THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE:

THE JOURNAL OF

THE POSTAL MICROSCOPICAL SOCIETY.

EDITED BY

ALFRED ALLEN,

Honorary Secretary of the Postal Microscopical Society.

ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

VOL. VI.

London:

BAILLIÈRE, TINDALL, & COX, KING WILLIAM ST., STRAND, W.C.

Bath:

1 CAMBRIDGE PLACE.

1887.

Preface.

THE Sixth Volume closes the First Series of THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE, formerly called *The Journal of the Postal Microscopical Society*.

We sincerely hope that the place in your libraries which was at the first granted from a kind desire to help forward a work on microscopy just struggling into existence, will, after six years of its publication and literary life, be continued to it, not from mere favour, but because it has won its way and confirmed its position by real worth and solid value.

It has been deemed advisable to begin a New Series with the Seventh Volume of this Journal. The first part of that series will be published in January, 1888, and several new departments of interest to the microscopist and to the student of natural science will be entered upon.

We have received promises from many naturalists and scientists of undoubted ability to furnish papers for the new

series, and we are assured that the seventh volume of the Journal will be in no respects inferior to any of its predecessors, either in value or in interest.

It remains for us only to thank our numerous contributors and subscribers for their much-valued support, and to beg that they will favour us with a further continuance of the same.

> "Mine eye unworthy seems to read
>   One page of Nature's beauteous book;
> It lies before me, fair outspread—
>   I only cast a wistful look."
>
> KEBLE.

THE JOURNAL OF MICROSCOPY
AND
NATURAL SCIENCE:
THE JOURNAL OF
THE POSTAL MICROSCOPICAL SOCIETY.

JANUARY, 1887.

Presidential Address.

By J. W. MEASURES, M.R.C.S.ENG.

EVER since the receipt of Mr. Allen's letter informing me that your choice for the office of President-elect had fallen upon me, I have in vain been endeavouring to discover the reasons which led to that selection, and can assure you that my feelings of surprise have not been diminished by time; but like the fly in amber, I still wonder "why I am here," and can only thank you, either for your discernment of qualities which you suppose me to possess, or for your great kindness in bestowing the highest honour in your power upon a member now of some years' standing. This honour I highly appreciate, and with a deep sense of my own inability to fill worthily the place heretofore occupied by more distinguished men, must beg your kindest indulgence and forbearance.

We meet here as members of a society, whose one bond of

union is an interest in some one or more of the branches of science, in which the Microscope is an essential aid. These are so varied and extensive, that scarcely any branch of modern enquiry can be said to be independent of its assistance. Neither the botanist, biologist, chemist, geologist, nor the students of any department of natural history, can altogether dispense with its services.

The attractions and uses of the Microscope being so multifarious, it need be no matter of surprise that Microscopical Societies should have sprung up in so many different parts of the country, each with its special field of work.

What, then, is the special mission of the Postal Microscopical Society? Let us seek an answer in its history: What was the first conception of the society by Mr. Atkinson, its first President? He says in his first letter to *Science Gossip*, in May, 1873, "Let a certain number of persons, living in different parts of the country, agree to form a Postal Cabinet Association," and in his letter he further developes a plan, which, after modification and assistance from Mr. Allen, our present secretary, resulted in the establishment of our society: the essence of the whole being the association of a number of workers separated from each other by long distances, and thus isolated in their work; but now, by means of the post, linked together into a brotherhood, and enabled to communicate with each other, and to obtain encouragement, sympathy, and instruction from intercommunication.

Now, of all the departments of Microscopical work, there is, perhaps, no other in which mutual sympathy and help is more needed, and in which one is more likely to be discouraged by isolation than the department of mounting objects for the Microscope. This is an especial trouble to young students and to those who are only in the outset of their microscopical career. Suppose, having become the possessor of a much-coveted instrument, the student essays to mount the simplest object—probably he has never seen an object mounted—how is he to go to work? He consults his books. But all persons of practical experience know how difficult it is to acquire any art from books, more particularly one so full of *minutiæ* as that of mounting. This art, which consists in displaying and preserving the minute

structures of any object, is not reached at one bound, and in many cases the isolated student is rather hindered than helped by books. He stumbles on without hints and without help. He has no one to give him any of those little tips, wrinkles, or dodges, which are so helpful. Books hinder by want of precision and attention to detail, and to their omission of all those little hints which are necessary in practice. No wonder, then, that after a few early attempts he desists, and his microscope is, as I have often seen it, laid upon the shelf to be almost forgotten. And on this point Beale ("How to Work with the Microscope") expresses his belief that "many who possess microscopes are deterred from attempting any branch of original investigation solely by the great difficulty they experience in surmounting the details.

How different is the position of the beginner in our large towns! I well remember with what pleasure I perused the reports of a mounting class, held at the Manchester Microscopical Society's rooms, where the various stages of dissecting, mounting, and displaying objects were superintended and practically illustrated by experienced mounters. But, alas! I knew of no one for miles round who took the slightest interest in the subject, and had I not heard of the Postal Microscopical Society, through the *British Medical Journal*, which thus said of our society:—"Such societies are extremely useful and agreeable institutions, and are, of course, particularly convenient to those who reside at a distance from great centres. They enable men to exchange specimens and ideas with other well-known workers, and to keep up their interest in practical histology, in a way often not otherwise easily attainable"—I, too, would probably have discontinued my attempts, but having joined its ranks my interest in microscopical pursuits has continued to this day. That this isolation is felt by the student to be an almost insuperable difficulty, and not a fanciful one, is proved by an instance related in the first address given by my illustrious predecessor in this chair, Mr. Tuffen West, and the whole passage is worth quoting, as many of our later members may not have seen it. He says:—

"Workers in isolated spots should have our first consideration.

It was for their benefit especially that the society was formed ; it is on such that the arrival of a box of our slides, with its accompanying book of notes and drawings, confers the greatest boon. None but those who have experienced it can fully realise the state of stagnation into which even an active mind may sink, with no fellow-worker at hand ; none with whom to communicate on subjects enlightening and elevating such as these. Some years ago I was spending a few days with a nobleman of high culture, extensive knowledge, scientific tastes, and a worker too ; perhaps the most original-minded man I ever met. Our converse was upon the best mode of publishing results he had obtained of great novelty and value, on the development of the vegetable cell. It was he who discovered the varying affinities of cell-growths for colouring agents, the knowledge of which has already borne such good fruit, and is destined still further to clear up many life-processes which are at present obscure. As the time of our parting approached he remarked, 'There isn't any one within fifty miles of me who cares aught about these things, and I feel as if I couldn't go on for lack of sympathy. I'm too far from London to profit by the Microscopical Society there, and I must give it up, though it has such a charm for me I would gladly work on.' And he has 'given it up.' That valuable original thinker and worker felt so disheartened by his surroundings that he fairly gave in to them, and this, his first great contribution to microscopical science, seems likely to be his last. How glad would he have been to have joined a society like ours, and how greatly would science have been the gainer in such an event."

The nobleman here referred to was, I believe, Lord S. G. Osborne, whose observations were made by allowing plants to grow in a solution of carmine, and then examining the growing parts. If such an observer, with all the advantages of time and leisure, and real genius, is thus discouraged by want of sympathy, I think we may fairly feel that we have here a real field of work, and that our mission is to assist the tyro, and encourage with our sympathy the isolated worker. For this our society was first established, and it now becomes us to enquire, Have we fulfilled our mission ?

A little enquiry into the geographical distribution of our members, and a glance at the excellent and interesting little map,

published in Vol. I. of our journal, will show that they are to be found in the most remote parts of England ; some in Scotland, some in Ireland, and some even in Portugal; and will prove that our society *is* filling the field of work marked out for it by its founders.

Of course, no society like ours can have existed for thirteen years without having met with practical difficulties and hindrances. In the pages of the earlier note-books and presidential addresses, numerous complaints are to be found of breakages of slides; thus, one essential to progress, the safe transit of slides, had to be, if possible, secured. The question of boxes long vexed the members of the society, so important was it deemed, and so truly important was it that a prize was offered for the best box. Twenty-one boxes were sent in to compete, and of these twelve were subjected to practical use, a test before the days of the parcel post, and much more severe than now, when a breakage is a comparative rarity, and the prize was duly adjudged to Mr. C. D. Holmes, but these boxes had in their turn to give way to others, the invention, I believe, of our worthy secretary. Then, too, there were many complaints with respect to the quality, and more particularly the repetition of slides ; complaints also of the circulation of slides of commonplace objects, and of the want of relation of one slide to another. On this point there can be no question that great progress has been made, and much of this progress is unquestionably due to the alteration in the rules made at the annual meeting, held Oct. 11, 1883.

I am sure that all the members of our society will acknowledge that the plan of sending six or more slides in one box, instead of four slides in as many separate boxes, has been attended with the happiest results. Better slides have been circulated. Series of slides illustrating varying points of structure in allied species of animals and plants having become possible, the opportunity has been seized by many members, and our boxes of slides and their accompanying books of notes have alike gained in coherency and interest to an extent even greater than was anticipated.

The question of the preservation and publication of our notes

had long proved an insoluble difficulty, but "as all things come to him who waits," so also this problem has found its solution in the publication of our very excellent journal, edited by Mr. Allen. This journal has already attained a very wide circulation—a circulation due entirely to its own merits, and all members of the Postal Microscopical Society ought to give it their earnest support. The following is the testimony of a gentleman, a member of various learned societies, whom I invited to join us, but who is at present unable to do so. He says:—"I have a very good opinion of your society, *derived from a perusal of its publications*, which I have taken from their commencement." In this journal not only have we had many original papers far too long for our circulating manuscript note-books, but many interesting items have been drawn from our old note-books, wherein they were entombed.

It is beyond question that the microscope may be used both as a means of affording amusement, and as an instrument for scientific research. It has occasionally been made a reproach to our association, that it is mainly used for the former purpose—amusement—and that the chief end of the society has been the circulation of "Objects *for* the Microscope." Supposing this reproach to be true, which it is not, is it possible, I ask, to use the Microscope as a means of amusement—that is, to gratify the eye without occupying, stimulating, and enlarging the mind? I unhesitatingly avow the contrary: it is not possible. Can any man or woman view without thought the beautiful revelations of the diaphanous and exquisitely-formed Daphnia, or Rotifer, or Floscule? Is it possible, think you, that anyone can thus view the workings of the interior economy of these beautiful little creatures without some reflections on the perfection of the unseen. Is it nothing, then, that our friends should be able to combine for "intellectual amusement"? We may not be able (and indeed all are not adapted by bent of mind) to adduce much original work as the result of the workings of our society, yet it has been helpful to many, and may even now be preparing some few of its members to such an end. For original workers are not born; they must be trained. Especially is this true of microscopical workers. Dr. Beale says:—"For however some may be inclined to disparage hand work as distinguished from head work, it is certain that no

one can become a good microscopical observer unless he is possessed of considerable manual dexterity, to be acquired only by long practice," and no work can be higher or more useful than that of assisting men to become original workers in any department of science.

Even the wide range of subjects over which our slides are spread tends to prevent the specialist from becoming too narrow, and to show him that there is an interest in pursuits other than his own. It is not at all desirable that we should imitate the coleopterist of Oliver Wendell Holmes. In our society he may learn much that has been previously done; the mission, though humble, should not be despised, for even as the known is the foundation of the unknown, so no original observer may or can safely disregard the studies of his predecessors.

I would now appeal to the members of the society to do all they can in the coming session to advance its interests by contributing interesting slides, adding to the slides notes, giving freely all their knowledge, either original or acquired. By so doing we shall attain in the future an even greater degree of prosperity than in the present.

Noctiluca Miliaris.

By Alfred W. Griffin.

Plate I.

There is, perhaps, no one of the phosphorescent animals yet known to science which possesses such highly luminous properties as the Noctiluca. To its presence in countless myriads upon the upper stratum of the water on calm summer nights is especially due that diffused form of phosphorescence, which is so essentially characteristic of temperate latitudes. Under the most favourable of these conditions the waves falling upon the shore leave, as they retreat, a glittering carpet of scintillating points, the oars of the passing boats seem to dip, as it were, in molten silver, while on the high seas the waste of waters churned

into foam by the revolving screw or paddles of the steamboat, leaves in its wake a broad luminous track, as far as the eye can reach. A glassful of water, taken from the surface of the sea at such times, at once reveals the cause of this wonderful phenomenon ; for here and there will be seen floating minute bladder-like, transparent spheres. When irritated they at once respond by flashes of green silvery lights, and it is to this that the beautiful appearance already alluded to is due.

This description is from the pen of Professor Allman, who has studied the Noctiluca very closely in its various stages, and I venture to think he has under-rated rather than over-rated the brilliancy of the phosphorescence. It was my good fortune on a still moonlight night, last August, to be off the coast of North Devon, and for some time to witness the appearance of molten iron, which the paddles of the steamer caused as they churned up the water, illumined on its surface by myriads of these tiny lamps. The crests of the waves as they rippled against the shore were sparkling with light, defining their form in sharp outline, and all around the vessel the luminosity was most brilliant. The beauty of the scene led me to commence these investigations, which I have now the honour to place before the readers of this journal.

According to Suriray, *Noctiluca Miliaris* consists of a spherical, gelatinous mass, with a long filiform tentacle appendage, possessing an œsophagus, many stomachs, and ramifying ovaries. Huxley, however, describes the Noctiluca somewhat more explicitly, by first stating that it is about the sixtieth part of an inch in diameter, and next, that in appearance it closely resembles a peach—that is, one surface is a little excavated, whilst a groove runs from one side of the excavation half way up to the other pole. Where the stalk of the peach might be is a filiform tentacle equal in length to about the diameter of the body, which exhibits slow wavy motions when the creature is in full activity. The use of this appears to be chiefly to push away obstacles and as a motive power, and I venture to hazard the opinion that it is a greater sympathetic nerve communicating with lesser nerves, and thence to the luminous points at the apex of the body. If the water is agitated in which the Noctiluca is confined, or an

irritating substance like Ammonia be added, the tail, or tentacle is seen in rapid motion, and the light flashes out with great rapidity. This tentacle is extremely brittle, breaks with a short fracture, and is evidently composed of rings of spiral tissue. Dr. Webb states that he has never seen any restoration of this part should it be lost, and on the death of the creature it coils up ; but I should add that even after the partial rupture of the investing membrane, and the discharge of its contents, he has seen it vibrating most vigorously. A very shallow cell in an ordinary glass slip is the most convenient method of examining the motions of this organ as it swims towards the under surface of the glass. The powerful uses for which this tail is employed require undoubtedly that it should be composed of strong muscular fibre. There is, however, a considerable measure of doubt as to whether or no there is any opening, or mouth, at its extremity.

The body itself is composed of a dense external membrane, continued on to the tentacle, and underlying this is a gelatinous membrane, throughout which minute granules are indiscriminately scattered. From this membrane arises a network of very delicate fibrils, possibly not more than one three-thousandth part of an inch in diameter, and these passing internally, become more open till they are merged into coarser fibrils, which converge toward the stomach and nucleus. All these are covered with granules, which are generally larger toward the centre. Quatrefages thinks that these granules move with the contraction and expansion of the membrane in which they are embedded. Supposing that we are viewing the animal in front, the oral aperture will be found on the right side of the groove, a little distance below the tentacle, which is on the left. This mouth-like organ appears in the character of a short oval tube, consisting most probably of striated muscular fibre, leading into the granular mass of the alimentary canal, and from this latter the fibres and fibrils radiate. Near the point of insertion of this oral aperture there is always a mass of sand and other substances adhering with great tenacity to a semi-granular material, with a hernia-like projection, and this substance is continued internally in much larger proportions. There appears to be an utter absence of anything like a digestive canal, but in the middle of this granular matter there are more frequently

vacuoles of more or less size, which have been considered by early writers, as Krohn and Suriray, to be veritable stomachs. These vacuoles are by no means synonymous with the shifting vacuoles of the Infusoria and Rhizopoda. Huxley's idea is that the oral cavity ends in a definite stomach capable of great dilation locally, and these dilations are connected by very narrow pedicles with the central cavity, such giving the appearance of "independent vacuoles." Brightwell's idea is that these "vacuoles," or vesicles, are temporary stomachs, or sacs, formed in the sarcode mass as they are required for the reception and digestion of food, and that they cease to exist after the food is digested. More recent investigations have shown that the food drawn into the mouth is received into the protoplasmic mass at the bottom of the œsophagus; extensions of this are formed which envelop the food with a filmy surrounding quite distinct from the protoplasmic mass. By this means we have "digestive vesicles" formed. These, however, soon pass into the arms of the central mass till they are surrounded completely by the protoplasm. The number of the vesicles vary from four to even twelve, and their place is subject to constant change through the movement of the substance in which they are embedded. The reticulations round the central mass are constantly changing, and thus the distribution of the nutrient material takes place as it finds its way into this network, through the walls of the digestive vesicles. Their contents are found to be principally Algæ and Diatoms. That singular diatom, *Rhizosolenia styliformis*, was found first of all in the Noctiluca, though it has been since seen floating in large masses on the surface of the sea; the chief form of Diatom, however, found in this Rhizopod is *Actinocyclus undulatus*. As the Noctiluca is so transparent, the form of the Diatom may be seen at a glance. After it has been in the vescicle for a few days it disappears altogether; probably the endochrome has been digested, and the siliceous frustule subsequently rejected.

The principal agent employed in conveying the food into the aperture, which does duty for a mouth, is a very delicate filament, or "flagellum," similar in character to a cilium, of the Rotifer type, which vibrates rapidly, and is as rapidly withdrawn inside. This band-like organ gradually narrows towards its extremity, and

its axis shows through its entire length transverse striæ. It seems to have the power of elevating its edges, so as to render one of its surfaces concave, and thus to form a tube-like process. This flagellum must not be confounded with the whip-like tentacle to which I have already referred, though there are some points of resemblance between the two: their position and difference in size form the great distinction.

As many, however, as fifty individuals may sometimes be examined without discovering this minute organ. The tail-like tentacle may be easily seen with a pocket-lens, whilst a quarter-inch objective will be required to discern the cilium, or flagellum. Springing from the base of this tail-like appendage to the edge of the oral aperture is a ridge-like prominence, something in the shape of the letter S, apparently of a horny nature, and crowning this ridge is a tooth-like process, with three cusps, or divisions of unequal character. This tooth is one seven thousandth part of an inch high. Professor Huxley states that he has seen no movement in this organ; but another writer, Dr. Webb, throws some light on the subject by stating that he has seen the ridge contract, and that he has observed a backward and forward movement of the tooth as though working on an axis. It is easily broken, and becomes shrivelled up by the use of astringents.

With regard to an excretory aperture, sound observers have come to the conclusion that egesta are voided from the mouth, but the opinion of the few writers that we have upon this subject appears to be much divided. Just below this mouth-like aperture, or tube, there is a depression corresponding in shape, as I have said before, with an ordinary peach, and the base of this depression, which is funnel-shaped, appears to have some communication with one of the gastric pouches. Krohn states that he saw excrementa voided from the groove of the body, but he is unable to define the exact point. Huxley, though he has no precise data to go upon, thinks that from the general structure of the organism, a distinct anus must exist, and that the funnel-shaped communication must, therefore, serve that purpose.

From the rapid apparent change of shape which the Noctiluca presents whilst swimming about, and its continual alteration of position, it is by no means easy to get a clear and uninterrupted

view of it, and it is an equally difficult task to mount it for observation, as most media have hitherto failed. At my suggestion, a weak solution of mercuric bichloride has been tried but without success. The inner membrane, as usual, wrinkled up, and the outer distended itself, and finally burst. I believe, however, it has been preserved in a shallow cell, with sea-water as a medium, containing just a trace of carbolic acid, but I have not heard whether this has been satisfactory during a lengthened period.

If iodine is added to the water, it is rapidly absorbed into the system, the fibres and fibrils permeated by the brown colouring matter standing out with great distinctness. Indigo was placed in the water, but none of the colouring matter entered the body of the Noctiluca, and the animal died in about an hour. Irregular jerking movements took place, says Dr. Webb; the mouth-like aperture and parts round it became distorted, the motion of the cilium and tentacle still continuing, general contraction took place, and then followed the disintegration to which I have already alluded.

This process occupied about two hours, but let me add that the nucleus was not involved in the operation. The nucleus is a strongly refractive body of about one four hundred and sixtieth part of an inch, situated in front of and above the gastric cavity, and when treated with acetic acid assumes the appearance of a hollow vesicle. If the body of the Noctiluca has been ruptured, and nearly all the contents lost, the creature still lives in this deformed condition, provided the nucleus is entire, and the central parts are left together. And then, after a time, they acquire a new investment, the rags of the old garment being contemptuously cast off. Dr. Webb further states that he has found this nucleus enclosed in a second membraneous envelope, with a granular yelk-like fluid, which could be seen pouring out when the membrane was ruptured.

The earlier writers on the subject before us came to the conclusion that the mode of reproduction was most probably by subdivision; it remained, however, for Colonel Baddeley to throw still further light on the subject by closer attention and more searching investigation. And the result of his observations are practically these: A division of the nucleus having taken place, it

is somewhat remarkable that the tail, or tentacle, is next formed; the secondary stage is that the divided nuclei remove far apart, and looking at the animal from the under side, we shall see that a division is commencing; in the next stage the form assumes that of the dumb-bell, but with a decided thickening in the middle. In the further development the self-division becomes complete, and the two individuals are held together like the Siamese twins by a single cord. The process of division is then completed by the rupture of the connecting portion, and the final absorption of the abnormal part. The whole operation takes place within a few days, for in a gathering made by a writer on this subject, on March 7th numerous double specimens were seen; on the 13th only two double specimens could be found held together by a slight band, and after that date no double specimens could be seen.

Cienkowski states that even a small portion of the protoplasm of a mutilated Noctiluca will reproduce an entire animal. Multiplication by fission, beginning in the enlargement and ultimate separation of the two halves of the nucleus, has also been observed. Another form of non-sexual reproduction commences in an encysting process, not unlike the swarm spores of many Protophytes. The flagellum and tentacle disappear on the narrowing up of the mouth, which finally closes, the median groove is no longer seen, and the result is that the animal becomes simply a hollow sphere. Then follows the elongation of the nucleus, its transverse constriction, and the division of the halves, with the exception that each is connected to the other by a bridge of network. This is repeated over and over again till you have a mass of some five hundred gemmules. Sometimes there is a detaching of the mass as a whole, and sometimes, and perhaps I should add more commonly, the gemmules detach themselves one by one, commencing at the edge of these colonial habitations, and proceeding to the centre. In the early stage the gemmules are simply spheres of the monad type, and contain their nucleus, contractile vesicle, and tentacle; then follows the mouth, and the formation of the permanent flagellum and tentacle. The true position in the animal kingdom of the Noctiluca is relegated to the flagellate infusoria.

From the month of July to December, there is but slight difficulty in procuring specimens for observation, and during these months the sea has shown incessant alternations of luminosity and darkness. These conditions, therefore, probably depend not merely upon the presence or absence of the animal itself, but on some peculiar conditions of its organism, or of the water acting upon the animals. The buoyancy of the Noctiluca is such that it rises to the surface of tranquil water without much effort, and may easily be procured. When kept in a test tube they will flourish for two or three weeks without the water being changed, and if at the end of that term they die, it will most probably be from some accidental cause rather than from the limitation of space. If specimens be sent through the medium of the post, the violent shaking thus occasioned is generally the cause of great mortality amongst them.

It was stated by a speaker at a meeting of the British Association that the Noctiluca had occurred that year in such vast numbers that the sea had become a beautiful rose colour, and Captain Wilson Barber, commander of the T.S.S. *Dacia*, states the following in a recent number of *Science Gossip*:—

"I have just been up the Persian Gulf laying a cable, and while we were proceeding from Jack up the Persian Gulf, we encountered immense numbers of the minute phosphorescent *Noctiluca Miliaris*, the centre reddish speck of which caused the water to appear in places as if covered with clotted blood. It was of the most intensely red colour, appearing in streaks and blotches all around. I caught quantities of it for examination. The water in places, when fished up in a bucket, seemed one mass of them, though in a small quantity they lost a good deal of their colour. Mixed up with them were a few pieces of *Trichodesmium Ehrenbergii*, but very little. There were also quantites of sea-snakes and medusæ. The sea was quite calm, and at night the steamer stirred up the most brilliant green waves I ever saw."*

Of the nature of the phosphorescence, Professor Allman states the following:—"When transferred from the net to a jar of sea water, the Noctiluca soon rise to the surface, where they habitually

* The red speck to which the writer referred was simply the mass of protoplasmic matter, clearly seen through the transparent body of the animal.

remain as a thick stratum, whilst the slightest agitation of the jar in the dark will cause instant emission of their light. This is of a beautiful greenish tint, and is so vivid that absolute darkness is by no means necessary to render it visible, for even by ordinary lamp-light it is quite perceptible. The emission of the light is but of instantaneous duration, and rest is needed for a repetition of the display. A few moments, however, will suffice for this, and the light is then as brilliant as before. Any other animals confined in the glass coming in contact with the Noctiluca cause it to light up the jar with its beautiful phosphorescence. Even the towing net, which has been employed in their capture, will continue, when shaken in a dark room, to exhibit brilliant scintillations provided any of these organisms are adhering to it. Noctiluca differs from *Beroe*, another of the most brilliantly luminous animals of our shores, in the fact that a prolonged withdrawal from the sunlight is not necessary in order to render it capable of phosphorescence, whilst *Beroe* must be kept in the dark for some time before its luminosity can be excited by irritation. Noctiluca, on the other hand, will show no impairment of its powers, even at the moment of its being removed from broad sunlight into a darkened room. The special seat of phosphorescence is most probably in the peripheral layer of protoplasm, which lines the external membrane. An easy way of examining this protozoon is obtained by placing it in an excavated glass slip with some sea water, a few inches off place a strip of white blotting paper, at the end of this make a tiny pool of alcohol, this will gradually drain off into the miniature sea in which the Noctiluca is disporting itself. As soon as the alcohol becomes mixed with the sea water, the light flashes out from the whole surface of the body, and as the proportion of the irritating spirit increases in the cell, so will the brilliancy of the luminosity. After a few seconds this gradually diminishes till nothing is left but a luminous ring, which soon goes out, and the brief life of the Noctiluca is concluded.

EXPLANATION OF PLATE I.

Fig. 1.—*Noctiluca miliaris:* *a*, the outer surface of the "tooth"; *b*, oral aperture; *c*, the position of the supposed anal aperture.

Fig. 2.—Oral orifice, × 400 : *f.*, flagellum.
,, 3.—Prehensile and trembling organ : *f.*, flagellum ; *t.*, tooth ; × 960.
,, 4.—Early stage of self-division, division of the nucleus having taken place, with development of the tail.
,, 5.—A further stage of development.
,, 6.—A still further progress towards division.
,, 7.—Self-division, nearly complete.

Drawn by A. W. Griffin.

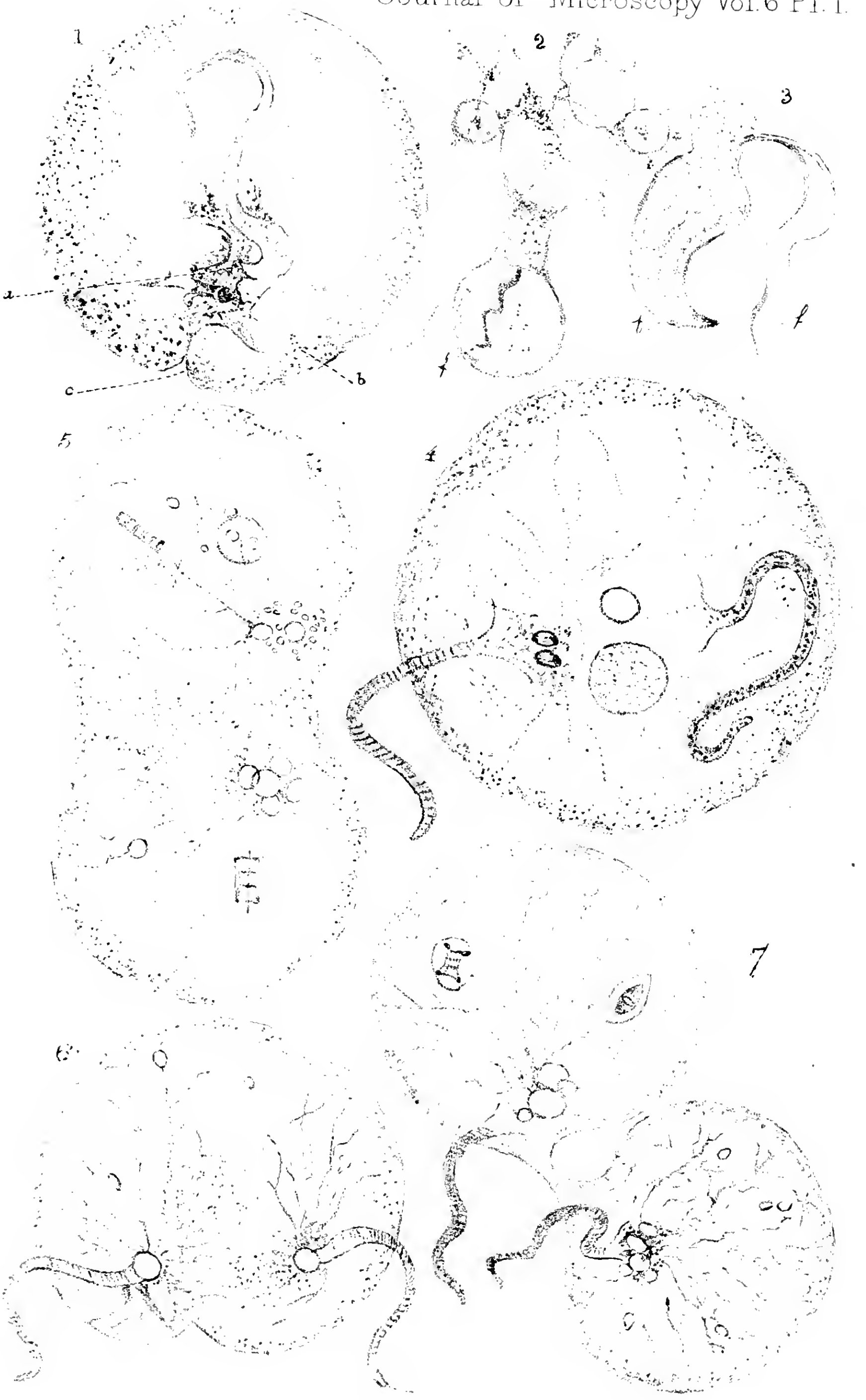
The Excessive Voracity of the Female Mantis.*

A FEW days since, I brought a male of *Mantis Carolina* to a friend who had been keeping a solitary female as a pet. Placing them in the same jar, the male, in alarm, endeavoured to escape. In a few minutes the female succeeded in grasping him. She first bit off his left front tarsus, and consumed the tibia and femur. Next she gnawed out his left eye. At this the male seemed to realise his proximity to one of the opposite sex, and began to make vain endeavours to mate. The female next ate up his right front leg, and then entirely decapitated him, devouring his head and gnawing into his thorax. Not until she had eaten all of his thorax except about three millimetres, did she stop to rest. All this while the male had continued his vain attempts to obtain entrance at the valvules, and he now succeeded, as she voluntarily spread the parts open, and union took place. She remained quiet for four hours, and the remnant ot the male gave occasional signs of life by a movement of one of his remaining tarsi for three hours. The next morning she had entirely rid herself of her spouse, and nothing but his wings remained.

The female was apparently full-fed when the male was placed with her, and had always been plentifully supplied with food.

The extraordinary vitality of the species which permits a fragment of the male to perform the act of impregnation is necessary on

* From *Science*.



Noctiluca.

account of the rapacity of the female, and it seems to be only by accident that a male ever escapes alive from the embraces of his partner.

Westwood quotes from the *Journal de Physique*, 1784, an instance in which the female of the European species—*Mantis religiosa*—decapitated the male before mating; but I know of no record of a similar occurrence with *M. carolina*, nor of the further mutilation described above.

Riley, in his "First Monthly Report," p. 151, says: "The female being the strongest and most voracious, the male, in making his advances, has to risk his life many times, and only succeeds in grasping her by slyly and suddenly surprising her; and even then he frequently gets remorselessly devoured."

In Packard's "Guide," p. 575, we find, "Professor Sanborn Tenney tells me he has observed the female after sexual union devour the male."

L. O. HOWARD.

Washington D.C., Sept 27.

Thirty-six Hours' Hunting among the Lepidoptera and Hymenoptera of Middlesex; With Notes on the Methods adopted for their Capture.

BY SYDNEY T. KLEIN, F.R.A.S., etc., Hon. Secretary and Treasurer to the County of Middlesex Natural History and Science Society.

IT is only a few months ago that the Provisional Committee, the nucleus of the present Society, was formed, and the critical remarks of certain scientists, together with the obstacles attendant on every new movement, which have to be overcome before good work can be done, are therefore fresh in the memories of many of those present. For my part, I think there were only two aspersions thrown at this movement, which, coming from competent sources, made me a little uneasy until I was able to

prove that they were groundless, and as this is the first evening meeting of the Society for practical work, it will not, I think, be out of place if, before entering on the subject of this paper, I say a few words concerning the reason why I took this work in hand. The time I was able to give to it was unfortunately very restricted, and I must therefore ask you to make allowance for any shortcomings, both in the results and the way in which I place the matter before you to-night. As I said before, there were only two aspersions thrown at the young Society which gave me some uneasiness until I was able to prove them groundless. These were as follows:—

First.—It was suggested "that the Flora and Fauna of Middlesex had been so thrashed out that there was no need of any further Natural History Society."

Second.—The question was asked, "What was there to catch in a county, a great part of which was covered by London and its suburbs?"

Now, with regard to the first objection:—Before the present Society was founded, I made very careful enquiries through publishers and private sources to try and find some comprehensive list of the Fauna and Flora of Middlesex, but the search, on behalf of the Fauna especially, was quite unsuccessful, until in June I secured a list published this year by, probably, the most flourishing Natural History Society in Middlesex, and one that could boast of a special Fauna and Flora Committee. Now, though I am always an enthusiastic observer of insect life in all its stages, it was just sixteen years since I had taken and set any entomological specimen in England, and my hand might therefore be supposed to be somewhat out of practice; but in running through the list I missed so many species which long ago I had seen abounding both in Surrey and Hertfordshire and several species, the larvæ of which I had actually watched contentedly eating up the solid wood of my fruit-trees and the best of my flowering plants in the spring and summer of last year, the pupæ of many of which had also fallen to the spade of my gardener when taking up the bedding-out plants for the winter, that I determined to try some of the methods which I found so successful in years gone by:—I tried the experiment first with the Lepidoptera,

and although I could only give an hour or two late at night, and that only once or twice a week, the result was so conclusive that I felt no more alarmed at the suggestion, "that the Fauna of Middlesex had been so thrashed out that there was no need of the present Society." In the first five hours of my hunting I found I had captured in the imago stage alone over thirty species not mentioned in the list, and nearly sixty new species during the whole thirty-six hours. What made the result also still more striking was that I confined my hunting exclusively to my own garden.

I now come to the second question, namely—"What is there to catch in a county, a great part of which is covered by London and its suburbs?" It is with the object of opening up this subject that I ask your kind attention to what I wish to say to you to-night.

Being engaged in the city all day till late, I had no daylight hunting; my evenings also were, unfortunately, very much engaged, and during July, August, and September, I only succeeded in getting altogether twenty-one nights for this object, which were free from moonlight, east wind, ground-fog, and lime blossoms, and fit, therefore, for hunting. My operations began between nine o'clock and half-past nine and finished about eleven. I find by my notes that of the twenty-one nights, I had fifteen of over one and a-half hours, averaging nearly two hours each, and six nights of less than one and a-half hours, averaging about one hour each. This makes a total of about thirty-six hours, and in that time I reckon I examined between 8,000 and 12,000 specimens of Lepidoptera alone.

Now with regard to the method of capturing these insects. The net is of little use for night-work. I rely entirely on a glass bottle, with cyanide of potassium, even for such large species as *Mania maura*, *Catocala nupta*, or *Calocampa vetusta*. This, if fairly fresh, renders the insect insensible in five to ten seconds. The specimen is then at once turned into a similar bottle containing bruised laurel leaves, which kill and keep the insects perfectly relaxed for a month if necessary. My usual plan, however, when captures are heavy, is to pin them the same evening, placing them in a relaxing box lined with cork to wait time for setting. There are, however, some species which require the net, as they

seldom settle; the *Spingidæ* and many of the *Geometræ* come under this heading.

For attracting in numbers, there is no method more productive than what is called "sugaring," which comprises the painting of trees, flowers, leaves, palings, etc., with a concoction of the coarse brown sugar called *Foots*, treacle, and rum, and if a district is to be thoroughly worked this method must be systematically persevered with; in fact, the moths should never go without their supper, even on those nights when it is impossible to spare the time to examine the guests which have seated themselves at the board. This is one of the first laws of attraction in Lepidoptera science, which I discovered for myself in my earliest days of collecting. It is also very important to spread the repast *always* on the same spot. If this method is carried out systematically, the result is simply wonderful. On the majority of the nights I have examined over five hundred specimens, and on two or three nights when it was drizzling and otherwise propitious, there must have been over a thousand of all kinds partaking of the supper spread for them from nine to eleven. There are, of course, a great many of one species; at times, I have counted from twenty to thirty of *X. polyodon*, two or three deep, fighting over a small band of the nectar; but after removing them with the hand, I have often found a specimen or two of the beautiful little *Noctua plecta*, *Cosmia affinis*, *C. diffinis*, or, more rarely, *Agrotis puta*, quietly taking their supper, apparently quite unconscious of the surging mass of fighting giants around and above them, the relative sizes being about similar to thirty hippopotami fighting and struggling over a human being; in fact, *X. polyodon*, *T. pronuba*, and the like, become a regular nuisance, and many a good capture has been nipped in the bud by these clumsy fellows.

Another method of capture is by light. This is, perhaps, the most exciting means by which Lepidoptera may be attracted. It, however, necessitates very late hours; between eleven p.m. and half-past one in the morning, being, according to my experience, the best hours for prosecuting this style of hunting. All that is required is a room with as little furniture in it as possible, and a bright light; a lamp or gas jet can be used, provided the latter has a close-fitting globe;—The light is placed in an open window,

and, providing the evening is fairly propitious, it will not be many minutes before a dozen or so of moths are dashing madly about the ceiling; others will be seen resting on the window-sashes or on the glass itself, and may be taken at leisure or turned out of doors again if not required. From eleven o'clock onwards they gradually come in ever-increasing numbers—sometimes singly, at other times in threes and fours—until the whole room seems alive with insects of all sorts, Lepidoptera predominating. This used to be my favourite method of capture during my Surrey campaign, when time was of less ob ject than at present; many a night in June and July have I sat up with the sport fast and furious till the sun began to show itself in the north-east. I have not been able to give much time this season to this method, but have taken the following species.*

The next method I have to speak of is one in which advantage is taken of the attractiveness of the ladies among the Lepidoptera gentry, and to those who have not had experience or have not persevered in this art, the result is truly marvellous, and will sound very much like a fairy-tale. The "good taste" possessed by the males of Lepidoptera is shown to the greatest perfection among the *Bombycidæ*. On several occasions when on botanical excursions in Hertfordshire I have taken with me a female of *Bombyx quercus* or other *Bombycidæ*, fresh from the pupa, and, in a wooded country, provided the sun was hot and a gentle breeze blowing, I was certain of having within ten minutes a dozen of the opposite sex flying round me, and from time to time even settling on my shoulder or hand. On one occasion, after remaining, as an experiment, for some time on the same spot, we counted over forty of these large moths within fifty yards of us. By this method, if persevered with, it is possible to secure, in the finest condition, many specimens which, owing to their rapid flight, are otherwise difficult to capture, except when, towards the end of their career, they become battered and less vigorous in their flight. The *Nocturni*, as a rule, seem much more susceptible than any of the other groups. The *Cuspidates* come next, *Dicranura vinula* especially falling an easy prey wherever poplars and willows abound; on the other hand, the

* See list at the end of this paper.

Noctuæ and *Geometræ* seem to be very difficult to attract in this way, the only success I have had with them being among the *Ennomidæ* and *Boarmidæ*. In practising this method, it is absolutely necessary to procure the moth quite fresh from the pupa, as she loses her attractive powers after she has flown with her kindred. It is needless also to point out that only specimens of the opposite sex can be captured in this way.

The next methods I wish to mention are, I believe, quite original, as, although I practised them twenty years ago, I have never heard of anyone else having done so. The first of these takes advantage of that marvellous instinct by which the female moth deposits her eggs with unerring certainty on those plants only, the leaves of which are the natural food of the young larvæ. I well remember the first experiment I tried in that direction. It was, I think, in the month of June, on the southern slope of the Surrey hills, within a mile of the old town of Reigate. I had taken in the neighbourhood several specimens of *Smerinthus ocellatus*, *S. tiliæ*, and *S. populi*; one specimen of *Sphinx convolvuli*, and of course *S. ligustri* in plenty; but *D. galii* had always eluded my search. It was natural that I should hunt for its food-plant, *Galium verum*, and not finding it in the near neighbourhood, it was perhaps still more natural that I should plant a bed of this strong-scented yellow flower in a sunny corner, in the hope that somehow *D. galii* might make its home there. The time for this beautiful hawk-moth to fly had arrived, and for several days I watched anxiously for the hoped-for visitant. At last, one afternoon, as the sun was declining, a shadow glided swiftly past me and hovered over the bedstraw. I recognised it immediately, by its flight, as one of the *Sphingidæ*, but, though it was the right size, its bright pink body showed it was not *Galii*. It was soon lodged in my field-box, a magnificent specimen of *Chærocampa elpenor*, a moth I had never seen before in that neighbourhood, and yet before the month was out I had taken on that spot a full set of six of these beautiful insects, together with several specimens of *C. porcellus* and one of that magnificent flyer, *Macroglossa fuciformis*; the last-mentioned Bee-hawk was also quite unknown to that neighbourhood up to that time. Although I did not capture *D. galii*, the result of my first experiment was so

encouraging that I always made it, whenever possible, part of my season's campaign to try and extend my list of local species by this means. It is a most fascinating pursuit, and if I had more time I could give you some curious examples of surprises as well as successes experienced in that direction. It is, in my opinion, by far the best and surest method of capturing specialities, and if I could persuade half-a-dozen members who are resident in Middlesex to take it up energetically, the list of Lepidoptera captured in this county would compare with any, and probably be ahead of many, of the southern counties.

The next method is applicable only to the *Sesidæ* and *Zeuzeridæ*, the larvæ of which live on the solid wood or in the twigs of certain trees and shrubs. The imagos of these emerge from about May to July, and if pieces of muslin are tied loosely round so as to form a sort of bag, over the notches, on young apple, pear, birch, or alder trees, about April, many of this family can be obtained in splendid condition, fresh from the pupæ. I took three specimens of *S. myopæformis* from one notch of a young apple-tree, and a great many of *S. tipuliformis* from dead currant-twigs. I have brought also a specimen of *S. tipuliformis*, which is interesting from having been captured in this room at our first general meeting, showing that even among the streets of London specimens of this sunny little creature can occasionally be found if properly looked for.

Beside the foregoing methods, there are, to be acquired only by experience, the two great desiderata for a successful entomologist—namely, the "habit of keeping one's eyes open" and "the knowledge of where to look for specimens." These habits become gradually so engrained in one's nature that they take the character almost of a *second sight*. I will try to explain what I mean:—I have repeatedly, when walking in the country or sometimes even in town, and during conversation, come to a full stop for, apparently even to myself, no reason whatever; in a few seconds, however, I generally found that some little excrescence or patch on paling, tree, or wall had riveted the eye, which on closer examination generally turned out to be a specimen either in the imago, larva, or pupa state. At times, however, the cause was not so apparent, the eye having probably wandered from the

object itself, and it would take many minutes to discover what had been seen only a few seconds before. There were also cases in which the eye had seen the object, but had not communicated the fact to the reasoning power until I had passed a considerable distance beyond the spot. It then came as a vivid remembrance of having seen a very suspicious object a short time before. This was the most curious case to investigate, as the mind had only taken hold of the appearance of the object itself, and it was seldom I could recall whether it was on a tree, or a fence, or on the ground. On such occasions, after a fruitless search, I have walked and re-walked past the spot in the hope that it would catch my eye again, but without avail. After several experiments on this phenomenon, I have come to the curious conclusion that the sight is most sensitive when the mind is thinking strongly on some other subject, and it would be an interesting thing for a psychologist to determine whether the phenomenon should be put down to *objective* or *subjective* intuition, or that old waste-paper basket for all mysterious workings of the brain, "*unconscious cerebration.*" It would be also interesting to hear whether others have experienced similar phenomena.

I have now mentioned the principal methods used for capturing insects in their perfect state. There are, however, many species which have seldom, if ever, been captured in the imago state, and until breeding cages came into vogue these were considered great rareties. There are three other states besides the imago in which they can be captured—namely, ovum, larva, and pupa:—The searching for ova, except in special instances, is not worth the candle, it being preferable to allow the young larvæ to hatch out and feed up to near maturity before taking them in hand. For the capture of larvæ there are, however, several methods. Many feed only at night, hiding themselves under leaves, stones, or even burying themselves in the earth, during the day. A walk round a garden in the daytime will show signs of larvæ on almost every plant; the stalks, leaves, flowers, and seed-pods are all tell-tales of the workings of the mandibles of some species or other; but the depredators are nowhere to be found, even with the most careful search. Take the same walk, however, at night with a lantern, and you will find hundreds of

them at work. For anybody who takes a lively interest in natural history, there can scarcely be a more fascinating pursuit than watching from night to night the life-history of these insects. You increase your acquaintance every day by fresh discoveries. Old friends drop off and new ones take their place. You know at any time where you are sure to find specimens of a certain species; you miss each of them regularly for a day or two each week or ten days when they are changing their heads and skins, and hardly recognise them at first when they return in their new attire.

I have been speaking only of flowering plants, but every tree and shrub has hundreds of larvæ if we will only have the patience and can spare the time to find them out, and each of them has a life-history of its own full of marvels. Much may be done in this way by a systematic investigation at night with a lantern, but if there are many trees and bushes to be examined, and that *continually*—as larvæ of fresh species hatch out weekly, daily, or even hourly—it is very desirable to have some indicator by which, without even taking the trouble to find the larvæ themselves, you may know they are there, and can watch their growth from day to day. My method for gaining this end is a simple and inexpensive one. Instead of throwing the newspaper away after being read, it is placed under a shrub or tree, wherever there is a chance of larvæ. This is repeated every day until you have a newspaper spread out under all those plants, shrubs, and trees you care to investigate. On going your rounds in the morning you find on most of these papers hundreds of small black pellets, the excrementa or frass of the larvæ feeding on the shrub in question. It is not difficult to find many of the larvæ at once, but there is no need of that, as they are very small. It is sufficient to watch the pellets as they increase in size day by day, and, with a little practice, it is often easy, without ever having seen the larvæ, to determine their species from the time of year and the food-plant:—As soon as the pellets become large, or they have been observed for about a month, it is time to find the larvæ and remove them to a breeding cage, in which a spray of the food-plant is kept fresh in a bottle of water, if you wish to continue your investigation to the pupa and imago stage. By this means many thousands of larvæ

of all kinds may be collected and their life-history thoroughly investigated by one person with the expenditure of very little time and trouble. It is truly wonderful how much may be done with a single newspaper spread under a pollard oak or even a hedge. In the spring every few days bring signs of fresh larvæ having been hatched. And when it is remembered that the life-history of many of these is very imperfectly known, an endless field for interesting and useful work is opened up to every one who has the true love of nature at heart, and is not satisfied to simply accumulate specimens for his cabinet. Another method of capturing larvæ is to beat or shake hedges, bushes, etc., over an open umbrella. This method, however, if carried out to any great extent, tends to ruin a neighbourhood entomologically, as in the process many ova and minute larvæ are destroyed.

I now come to the method for taking Lepidoptera in the pupa state, and as some of you may not have studied this branch of natural history to any extent, I thought it might be of interest if I brought specimens of the pupæ of each of the great divisions of Macro-lepidoptera. On the table you will find pupæ of the following:—

Smerinthus tiliæ, the Lime Hawk-Moth, representing the ... ... NOCTURNI.
Biston hirtaria, representing ... ... GEOMETRÆ.
Pygæra bucephala and *Dicranula vinula*, representing ... ... CUSPIDATES.
Hecatero serena, representing ... ... NOCTUÆ.
Pieris brassicæ, representing ... ... DIURNI.

Pupæ are to be found anywhere and everywhere. Some larvæ, like the *Pieridæ*, suspend themselves by a single cord placed round their waist, and turn thus to the pupa state. Others, like the *Vanessa* family, suspend themselves head downwards. Others spin hammocks on their food-plants; others spin leaves of trees together, taking care also, however, to fasten the leaves to the branch, so that when the leaves die in the autumn they do not fall to the ground, but remain securely fixed until the moth emerges in the spring; others gnaw the bark of trees, and with the *débris* build themselves a strong house so like the trunk of the

tree that it is very difficult to discover them unless the little mounds are tried with a penknife; others, and by far the larger number, bury themselves in the ground, spinning the particles of earth together, and in that house or coffin pass the winter until the warm spring weather brings them to maturity and they come forth perfect insects. If a locality or a county is to be worked thoroughly, digging for pupæ must be pushed energetically; it is a very fascinating pursuit, and would give subject enough for a paper by itself. You see, perhaps, a fine old oak tree situated in the centre of a field, well away from any hedge or underwood, and having several sheltered corners formed by the roots. It is a bright day at the commencement of September, and you prepare yourself for the attack; a small trowel is inserted within a few inches of the trunk well into the angle, and a sod is turned up and examined. By tapping the sod gently, the chrysalides will fall out of their earthen retreats, and by careful examinations of the trunk as well, many of the following, all of which I have taken in more or less abundance by this method, may be found:—*A. Aprilina*, in abundance, *H. pennaria*, *H. protea*, *C. ridens*, *D. dodonæa* and *chaonia*, *P. pilosaria*, *T. instabilis*, *cruda*, *munda*, *gothica*, and *miniosa*, *N. trepida*, *H. aurantiaria*, *A. prodromaria* and *A. betularia*. Other trees, such as elm, lime, alder, ash, poplar, willow, beech, etc., all have their special crysalides, and may be examined with success from September to April. I used to be very fond of this mode of capture, and seldom had less than 3,000 to 4,000 pupæ in my breeding cages during the winter months. *A. Aprilina* will be the first to fall to the trowel if digging round an oak tree. I once took 25 pupæ of this beautiful moth in a single crevice of an oak in Betchworth Park, and it was a rare occurrence for me after a day's pupa hunting to return home with less than a dozen or so of this species.

I have now said all I have to say about the *Lepidoptera*. In the cases on the table you will find all those specimens which I captured during the thirty-six hours of my experimental hunting, and it will probably be more interesting to you to see them than to hear them read out. I have not yet touched on the *Hymenoptera*, but I find my remarks have considerably outrun the limit of

time usually allotted to such papers, and although the next subject is, if anything, still more interesting, you will perhaps think it is better to leave it for a future occasion.

I will, however, with your permission, just touch briefly on three special exhibits which I have brought with me this evening, and which I think will be sufficient to show you how interesting is the subject, and what wonders there are around us of which many in their ordinary life have no conception.

I will first take the case of *Osmia rufa*, the mason bee. I have between thirty and forty natural hives or dwellings of this pretty little insect in the front of my house. It burrows a long tunnel into the mortar six to ten inches long, the diameter being so small that there is only just room for this little bee to squeeze itself in. It then commences to form a small cell at the end of this passage, which it fills with honey and pollen, and after depositing an egg therein, it seals up the end, and begins another cell. This it repeats until the tunnel is nearly filled. It then fills up the aperture with mortar, sticks, small stones, wool, or even small pieces of string, and plasters over the entrance with a sort of cement, to keep its young safe until next spring; the young comes out in a few days, and at once commences eating the honey and pollen, but its life is not always secure. There is a beautiful little insect, named *Chrysis ignita*, which you will generally find watching outside these holes, and which, as soon as *Osmia rufa* has finished her cell and flown away to gather fresh honey and pollen for the next cell, enters the tunnel and deposits her egg also in the cell. The larva of the *Chrysis* hatches out in a few days, and feeds either on the honey and pollen or on the larva of *Osmia rufa*, in the same way as the larvæ of the *Ichneumonidæ* live on the bodies of those of *Lepidoptera*. I have had some difficulty in getting any information on this head, but the general idea among authorities on *Hymenoptera* seems to be that the *Chrysidæ* do not follow the *Ichneumonidæ*, but feed on the honey instead of on the larva of *Osmia rufa*. I have, however, found the empty skin of a full-grown larva of *Osmia rufa* in its cell with the cell punctured evidently by a Chrysis, which would seem to prove that either the larva of the Chrysis lived in the body of the bee, or had eaten it up after the honey and pollen had been finished; the

latter case is, I think, however, very improbable; meanwhile, I have several now under investigation, and hope that by next summer I may be able to prove beyond doubt the true action of this parasite. I have found also that Shuckard, in his "British Bees," makes the assertion that the larva of *Osmia rufa* lives in its cell during the winter, and only turns to a pupa in the spring. This is quite erroneous, as you can see for yourselves to-night. I have here two cells taken from a tunnel of this little insect, both of which contained perfect insects, pròving a very curious fact, viz.—that the imago is actually developed in the autumn, but remains a prisoner enclosed in its cell until the spring. One of these cells I opened at the Entomological Society at the beginning of the month, and the little bee is at large; but I will open the other to-night, and let out the little prisoner for your inspection. A curious fact connected also with this little insect is that it is furnished with long hairs on the abdomen, by which means it carries its pollen, instead of, as with many bees, on its hind legs—a beautiful example of the provision of Nature, as the pellets of pollen would surely be rubbed off whilst coming down the burrows if they were carried in the ordinary way.

The next species I wish to mention is what is called the Leaf-cutter Bee—*Megachile centuncularis*. In the top bar of my front gate I have located three hives of this curious little bee, and at any time on a bright sunny afternoon, after standing by the gate for a few minutes, one at least of these little insects could be seen coming home with its burden; the sight is a curious one, as you see nothing except a small leaf coming towards you, and sailing round in circles smaller and smaller until it settles on the top bar of the gate. By careful examination, you can then see that in the centre of the leaf is this little bee holding the leaf by its legs. We will now go to the rose-tree from which it has taken this leaf; and here we find that almost every leaf on the tree, and many trees round, are cut up into most curious shapes by this little insect. If one is fortunate to see the bee at work, you will see it with its mandibles cutting out from the leaf a round piece about an inch in diameter. It then flies off to its nest, but his burrow in the wood is much too small for the leaf to go in, and you then see it cleverly rolling up the leaf and pushing it before it into the

hole. As soon as the roll is taken into the burrow and placed in its right position, the little bee cuts a very much smaller circular piece from the tree, and flies back again with it to fill up one end of this curious cell. It then flies off to collect sufficient honey and pollen to fill the cell, and, in the same way as *Osmia rufa*, lays an egg in the middle of this heap of food. It then once more cuts another small circular piece of leaf to fill up and complete the cell. This work it continues until it has four or five cells in its burrow, each of which contains an egg, to develop in time into a perfect *Megachile*. There is, however, an enemy to this bee also, in the form of *Trypoxylon figulus*, which lays its egg in the cell in the same way as *Chrysis ignita* does towards *Osmia rufa*.

I will now only mention one more subject connected with *Hymenoptera* which must end what I have to say to you to-night. In my garden I have several hives of *Apis ligustica*, an Italian bee, with a bright-coloured body. This is a domestic bee, and I keep it for its honey as well as for investigating the wonderfully interesting facts connected with its life-history. Many of you know without being told that there are three different kinds of bees in a hive, viz.—the Queen Bee, of which there is only one in each hive; the Drones, which are the males, and which are killed off as soon as the summer is over; and the Working Bees, which are undeveloped females and which do the whole work of the hive. The Queen lays between 2,000 to 3,000 eggs per day. The larva, after hatching out, lives only three or four days before it is full fed. It is then sealed up by the bees and turns into a chrysalis, which comes out into a perfect bee in about seventeen days. This is the usual round of metamorphosis in the worker bee. But the development of a Queen is still more wonderful. In view of having an exhibit for the Society, I took the Queen away from one of my hives, and within five minutes of my doing so the whole hive was in a terrible uproar; they found they were a colony without a head, and for nearly half-an-hour they were nearly mad, flying in thousands round about the hive in search of her. Within a few hours, however, they had quieted down, and on opening the hive I found that they had selected nearly a dozen eggs in cells in different parts of the hive, and were breaking down the walls of the cells all round in order to make a larger

cell. Within a few days the larvæ hatched out of these selected cells, and the bees were feeding them on what is called royal jelly, a stronger solution of honey and pollen than is given to the ordinary worker bee. Under this treatment the larvæ grew very quickly, and the cell soon formed the appearance of an acorn, hanging down below the frame. After another week I opened the hive, and found that the bees had been scraping the tops of these Queen-cells preparatory to the young Queens coming out, and within twenty-four hours one of the Queens emerged. And now comes the tragedy, of which my exhibit is an example. As soon as this new Queen had been thoroughly groomed down and fed, she immediately rushed round the hive to see whether she had any rivals. On finding the other Queen-cells she at once set to work to tear them open, stinging to death the pupa inside, and within ten minutes of her doing this the dead white nymphs were cast out of the front of the hive by the bees.

I have brought you two of these cells, showing the end where the bees had thinned the wax preparatory to the Queen coming forth, and also the large rent on the side of the cell through which the murder was committed.

This must finish what I have to say to you to-night. Meanwhile, I trust you will agree with me that the necessity for the present Society has to a certain extent been vindicated from, at all events, an entomological point of view; and I can only add that, should my words have been powerful enough to show what may be done by any member, however much engaged during the day, and should they encourage those who have more time than myself to investigate and accumulate facts concerning this and other branches of Natural History, the object I had in view when I undertook to bring the subject forward will have been fully accomplished.

List of Lepidoptera captured by Mr. Sidney T. Klein during thirty-six hours' experimental hunting in his garden at Clarence Lodge, Willesden.

NOCTURNI.

Smerinthus ocellatus, larvæ; *S. populi*, three imagos at light; *S. tiliæ*, larvæ.

Sphinx ligustri, larvæ.
Sesia myopæformis, three imagos from apple-tree; *S. tipuliformis*, very common from currant-twigs.
Hepialus lupulinus, came to light; *H. sylvinus*, ditto.
Nola cucullatella, to light.
Chelonia caja, very common; *C. villica*, one specimen at rest, on lilac-tree.
Arctia lubricepeda, very common, light; *A. menthastri*, ditto.
Liparis auriflua, common to light; *L. salicis*, one imago to light.
Orgyia pudibunda, larvæ; *O. antiqua*, larvæ.
Odonestis potatoria, three imagos, to light.

GEOMETRÆ.

Urapteryx sambucaria, very common.
Rumia cratægata, very common.
Metrocampa margaritata, one imago to light.
Selenia illunaria, common to light.
Crocallis elinguaria, common to light.
Ennomos tiliaria, not rare to light; *E. angularia*, ditto.
Hemerophila abruptaria, two imagos to light.
Boarmia rhomboidaria, very common.
Pseudopterpna cytisaria, two imagos to light.
Hemithea thymiaria, common to light.
Ypsipetes elutata, common.
Pelurga comitata, common.
Melanippe rivata, common; *M. montanata*, common; *M. fluctuata*, common.
Acidalia incanaria, one imago; *A. aversata*, common.
Eupithecia rectangulata, common; *E. centaureata*, common.
Timandra amataria, common.
Halia wavaria, very common to sugar.
Panagra petraria, scarce.
Aspilates gilvaria, scarce.
Abraxas grossulariata, very common.
Camptogramma bilineata, very common.
Phibalapteryx tersata, one specimen.
Scotosia dubitata, one specimen.
Cidaria dotata, common; *C. fulvata*, ditto.

Eubolia mensuraria, common.
Anaitis plagiata, one imago.

CUSPIDATES.

Pygæra bucephala, common.
Dicranura vinula, thirteen larvæ on poplar.
Cilix spinula, three imagos.
Ptilodontis palpina, one imago at sugar.

NOCTUÆ.

Bryophila perla, one specimen.
Acronycta psi, *A. aceris.*
Leucania conigera, *L. lithargyria*, *L. comma*, *L. impura*, *L. pallens.*
Gortyna flavago.
Hydræcia nictitans, *H. micacea.*
Axylia putris.
Xylophasia lithoxylia, *X. polyodon*, *X. hepatica*, one specimen, sugar.
Heliophobus popularis, three specimens to light.
Cerigo cytherea, one specimen to light.
Lupernia testacea.
Mamestra abjecta, one specimen at sugar; *M. auceps*, *M. brassicæ*, *M. persicariæ.*
Miana fasciuncula, *M. furuncula*, *M. strigilis* (var. *Æthiops*), abundant.
Grammesia trilinea.
Caradrina morpheus, *C. alsines.*
Agrotis puta, two specimens; *A. segetum*, common; *A. nigricans*, common; *A. suffusa*, common; *A. exclamationis*, *A. orbona*,
Tethea subtusa, four specimens.
Apamea oculea, several varieties.
Noctua festiva, *N. xanthographa*, *N. rubi*, *N. ambrosa*, *N. baja*, *N. augur*, *N. plecta*, *N. C. nigrum*, *N. triangulum.*
Triphæna Janthina, *T. fimbria*, three specimens; *T. orbona*, *T. pronuba.*
Anchocellis lunosa, three varieties; *A. pistacina.*

Cosmia trapezina, abundant; *C. diffinis*, common; *C. affinis*, common.

Dianthecia cucubali, one specimen.

Hecatera serena, two specimens.

Miselia oxyacanthæ.

Phlogophora meticulosa.

Euplexia lucipara, six specimens.

Epunda nigra.

Hadena proteus, *H. dentina*, *H. chenopodii*, *H. oleracea*, *H. thalassina*.

Caloampa vetusta, one specimen.

Abrostola triplasia, very common.

Plusia palchrina, one specimen; *P. gamma*, *P. iota*, *P. chrysitis*, three specimens.

Gonoptera libatrix.

Amphipyra pyramidea, two specimens; *A. tragopogonis*.

Mania maura, six specimens; *M. typica*.

Catocala nupta, abundant.

Whirligig Beetles.

By Robert Gillo.

Plate II.

EVERYBODY most probably know the Whirligig Beetles, yet perhaps few have ever examined them. I will therefore endeavour to describe what I think to be some of the principal features of their external structure, together with a short notice of the various species that inhabit Britain and constitute the genus Gyrinus. Even the most casual observer cannot have failed to observe that they are quite unlike any other of the water beetles; hence, in classification they stand alone and without any connecting links between them and the more usual forms of Aquatic Coleoptera, of which we may take the *Dytiscus* or *Acilius* as types.

In the first place, the eyes in the *Dytiscidæ* are two in number and are placed at the sides of the head, and protected from injury by the anterior angles of the thorax, which for this purpose are produced forward. In the *Gyrinidæ* the eyes are four in number, two being distinctly on the upper side of the head and the other two on its underside. The use of this arrangement is evident, for as the Gyrinus passes most of its existence spinning about on the surface of the water, these two pairs of eyes enable it not only to keep a look-out for any enemy that may attack it from above, but at the same time to be on the watch for prey, such as small insects that may be in the water, and perhaps also to make its escape from a voracious fish.

It is worthy of note, too, that the curvature or convexity of the upper and lower pairs of eyes are different; also, that the foci of the lenses of their corneas are dissimilar. By this means the upper pair are suited for viewing objects in the air, whereas the lower pair are adapted for seeing objects through the denser medium of the water. If a portion of the cornea of the upper eyes be placed by the side of a similar portion from the lower ones and mounted as a slide for the microscope, it will be found, on viewing any object through them, that the images of the object produced by the different corneas will appear of different sizes.

The antennæ of the *Dytiscidæ* are, as a rule, simple, although there are some modifications of a different but not very striking character. In the *Gyrinidæ*, however, they are peculiar, being unusually short and of a singular construction. The first joint is very small and the next very large, and of an ear-like form, fringed with hairs; the remaining joints are small and inserted at the side of this large joint, the arrangement somewhat resembling forms we find in the antennæ of the Diptera. They are inserted in large circular hollows at the sides of the head between the upper and lower pairs of eyes.

The legs also differ very widely from those of the normal type of water beetles. The front pair are essentially organs of prehension, and are employed for seizing insects, etc., and, considering the size of the beetle, they are large and powerful. The posterior pair are, on the other hand, organs for swimming, but not like those of the *Dytiscidæ*, which are constructed on the principle of

oars; these are rather in the form of paddles. The whole action of the insect in the water, as it performs its gyrations about in the sunshine, is not unlike that of a canoe dexterously propelled by the paddle. Perhaps, if we glance at the construction of the leg of the Dytiscus the difference will be more evident. It is long and narrow, the joints of the tarsus being elongated, the last being produced to a point and fringed with long hairs, so as to present, in the act of swimming, a large surface of resistance to the water; but owing to these hairs lying close to the leg they pass easily through the water, when it is drawn up preparatory to another stroke, feathering in a very effective and perfect manner. The posterior leg of a Gyrinus (Plate II., Fig. 6) is very short, each part being much widened out, and each joint of the tarsus enormously so on the inner side; and on the outer side both tibia and tarsus are fringed with long, strong bristles, so that when the leg is extended it presents a very large surface to the water, and yet, by the peculiarity of its construction, can be closed up in a fan-like manner into a very small compass. The intermediate legs are similar, but narrower.

The *Gyrinida*, unlike *Dytiscidæ*, pass the greater portion of their existence on the surface of the water, but they can dive exceedingly well, which they nearly always do when alarmed. They, however, do not remain long under the water, but very soon come up and re-commence their gyrations on the surface.

The sub-family, *Gyrinidæ*, contain only two genera: *Gyrinus* and *Orectochilus.* The genus *Gyrinus* contains ten British species; the genus *Orectochilus* only one, viz., *O. villosus.* It is smaller and rather different in shape to the true *Gyrini*, and instead of being smooth and polished it is hairy. It has also another peculiarity, namely—that it hides under leaves, etc., during the day and performs its evolutions on the water by night. The ten species of British *Gyrini* are very difficult to determine: in fact, I think it is almost impossible to make them out by any description, the differences consisting of peculiarities of form such as cannot be expressed in words, although they are evident enough by comparison when you are sufficiently familiar with the various species. Again: the males and females of some species differ, the females being duller and more punctured than the males. Others

of them have not this difference; or if they have, it is scarcely perceptible.

Students have of late derived an immense advantage from tabulating and stating only those characters which are necessary to determine and identify the insect under examination from all others. Let me try to explain. Suppose there are only two species in a genus, one of which is red and the other black. It is sufficient to state that fact only, and the species is determined as clearly as it could be by a whole page of description. Or, should there be many species, the red ones may be separated into one group and the black ones into another, and then some other characteristic selected for their further determination. In this way the genus *Gyrinus* is tabulated. By referring to the table at the end of this paper, it will be noticed that only two species have the under side of the body red—*G. minutus* and *G. urinator*. The first is a Scotch insect, so that when I noticed a Gyrinus red underneath, I knew at once I had *G. urinator*, as I could not expect to find *G. minutus* in Bath. At first I only found one specimen, but knowing it to be a rare insect I was determined to find more if possible, and for this purpose I made up my mind to try the canal* on both sides until I succeeded. I certainly felt very disappointed, after working for nearly two hours without any success. However, presently I came to a corner with a bank of *Anacharis* weed, and there they were in abundance, together with a still larger number of *G. marinus*. There were a few *G. natator* and *G. opacus*, and one *G. bicolor* only. I obtained about eighty specimens of *G. urinator*, nearly all of which have since been distributed to coleopterists in various parts of the country.

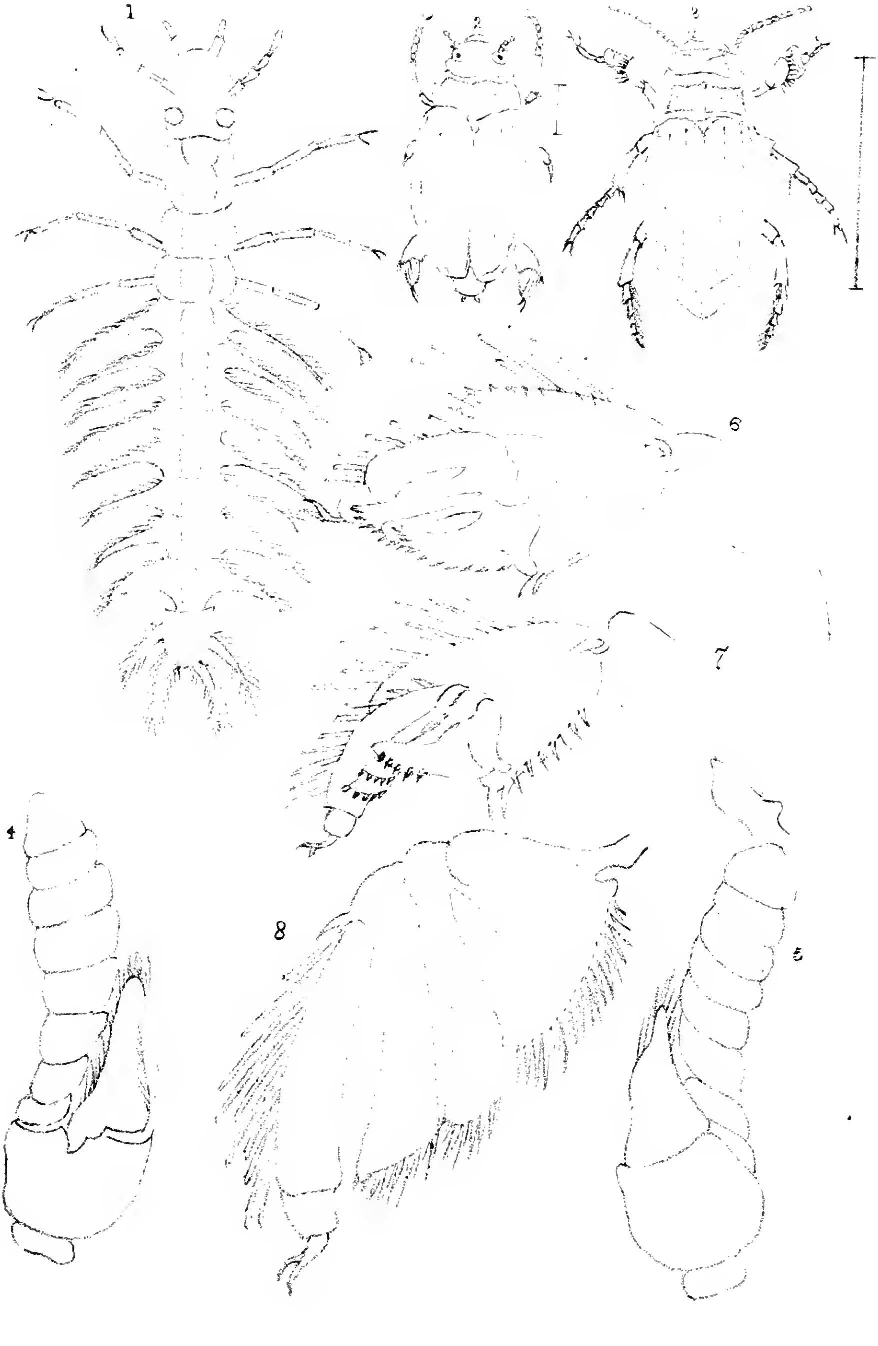
It is a very general idea that the commonest species is *G. natator*, but this certainly is not the case in Bath, *G. marinus* being far more common. I think *G. natator* occurs more freely in ponds than any of the other species. In the London district *G. natator* does not occur at all; at least, I am informed so by a friend who has collected beetles round London for ten years. From the name *Marinus*, one would suppose this species to be peculiar to localities near the sea; but such is not the case. It

* The Kennet and Avon Canal.

certainly does occur in such situations as ditches, in salt marshes, and I suppose was first found in a locality of this description and named accordingly. *G. bicolor*, however, is peculiar to marine situations, I have taken it in ditches near the sea at Weymouth, but I should never have expected to meet with it in the Bath canal. But there can be no doubt as to my specimen being *G. bicolor*, from the elongated shape and nearly parallel sides of the elytra. Another species, *G. distinctus*, I have taken from ditches at Bournemouth and there only.

I do not notice any sexual difference other than the punctuation which I have already alluded to. I find no trace of the enlargement of the anterior tarsus of the male, which is very striking and interesting in the *Dytiscidæ*. When touched or irritated, they emit a milky fluid of a disagreeable odour, which is discharged from the pores of different parts of the body, or, according to De Geer, from the minute retractile lobes at its extremity. It is stated that *G. minutus* and *G. villosus* are scentless. I do not know if this is so, as I have never taken either of these two insects. The membraneous wings are very large for the size of the insect, and, owing to the peculiar arrangement of the nervures, fold up in a remarkable manner.

"The female, shortly after impregnation, deposits her eggs, which are small and of a cylindrical form, and placed end to end in parallel rows on the leaves of aquatic plants, and from which, at the end of eight days, the larvæ are produced. The larva is long, narrow, and depressed, and nearly resembles a small centipede, of a dirty white colour, composed of thirteen segments, including the head, separated from each other by lateral incisions. The head is large, oval, and depressed, armed with two strong jaws, two short, filiform, four-jointed antennæ, several small tubercular eyes (the number of which De Geer could not discover), forming a group on each side of the head, and slender maxillary and labial palpi. The clypeus is deeply notched in front, without any distinctly articulated labrum. To each of the three anterior segments of the body is attached a pair of moderately long and slender legs; and from each side of each of the eight following segments arises a long, slender, transparent, and membraneous filament, bent rather backwards, and terminating in a point. The



Gyrinus.

terminal segment is furnished with two pairs of similar but much longer appendages. These filaments are employed as organs of respiration, each being internally provided with a delicate air-vessel, connected at the base with the ordinary lateral tracheæ. The body is terminated by four minute conical points, bent downwards, and which are used by the insect when in motion; whereas the long filaments have no peculiar motion. When the larva has attained its full size at the beginning of August, it creeps out of the water up the stems of the rushes or other aquatic plants, where it encloses itself in an oval cocoon, pointed at each end, composed of a substance spun out of its own body, and somewhat resembling grey paper, within which it becomes a pupa. In this condition it remains about a month, when it makes its appearance in the perfect state, and immediately resorts to its native element, the neighbouring water."

Such is the life-history and description of the larva given by Westwood, which appear not to be the result of his own observations, but largely, if not entirely, taken from those of De Geer. I have never seen this larva, but expect it is an exceedingly interesting microscopic object, and one which cannot be rare or very difficult to obtain. Our entomological readers will do well to be on the look-out for it another season.

EXPLANATION OF PLATE II.

Fig. 1.—Larva of Gyrinus.
,, 2.—Gyrinus natator.
,, 3.—Dytiscus marginalis.
,, 4, 5.—Upper and under side of antenna of Gyrinus.
,, 6.—Posterior leg of Gyrinus, with tarsus extended.
,, 7.—Ditto, only partially closed.
,, 8.—Tarsus of same, very much extended.

CHART OF THE GENUS GYRINUS.

The Genus GYRINUS.

- Underside entirely rust red .. ..
  - Punctures on elytra scarcely feebler toward suture .. **minutus**, Fab.
  - Punctures on elytra finer toward suture .. **urinator**, Ill.
- Underside, wholly or chiefly black, legs reddish.
  - Reflexed margin of thorax and elytra, reddish ..
    - Body ovate or oval.
      - Punctures on elytra distinctly finer toward suture .. **natator**, Scop.
      - Punctures on elytra scarcely finer toward suture .. **Suffriani**, Scrib.
    - Body elongate oblong, with nearly parallel sides .. .. **bicolor**, Payte.
    - Body oblong ovate.
      - Interstices on elytra impunctate .. **distinctus**, Hub.
      - Interstices on elytra indistinctly punctured .. **Caspius**, Mén.
      - Interstices on elytra closely and distinctly punctured .. **Colymbus**, Fr.
  - Reflexed margin of thorax and elytra, brassy black .. .. ..
    - Punctures on elytra scarcely finer toward suture .. **marinus**, Gyll.
    - Punctures on elytra much finer toward suture .. **opacus**, Sahlb.

The Microscope and how to use it.

By V. A. Latham, F.M.S.

Part VIII.—Injecting.

THE term injecting, in its micrological application signifies the filling of the arteries, veins, and other vessels of animals with coloured substances, for the purpose of showing their arrangement in relation to, and their course through, the tissues. Practice, patience, and perseverance are required to make good injections; still more does the remark apply to injecting morbid tissues, which have been excised out of the living body, as in this case there are so many vessels, which have been severed, requiring to be ligatured to prevent the escape of the injection. In cases of morbid tissues it is best to use *cold injections*, as heating often causes considerable alterations in the tissues, especially where there is much epithelium, which has already become somewhat changed during the period that has elapsed since death. Injections may be either *opaque* or *transparent*, each method having its special advantages. The former is most suitable where *solid form* and *inequalities of surface* are especially to be displayed; the latter is preferable where the injected substance is so thin as to be transparent (as in the case of the retina, etc.), or where the distribution of its blood vessels and their relation to other parts may be displayed by sections thin enough to be made transparent by mounting in such medias as Balsam and Dammar.

Let me beg of the amateur to note carefully the causes of each failure, and to take precautions to avoid these in his subsequent practice. If this is done, the art of injecting will be learned sooner and more easily than it otherwise could be. There are three well-known methods of making injections, which are as follows:—

(1) Injections made with a syringe.

(2) Mechanical injections, in which the function of the syringe is replaced by the pressure of a column of water, or mercury.

(3) Natural injections; or the introduction of pigments into the circulation of living animals.

This latter method is usually resorted to in cases where the two preceding processes are either altogether impracticable, or very difficult to perform; as, for example, the filling of the bile ducts throughout their course in the liver.

The second method of injection is very convenient when time cannot be spared to do the work by hand; but the first method (injection by hand with the syringe) is *the one* which should be mastered on account of its simplicity when once learned, less trouble, and the ease with which it can be performed.

The substances used for making injections may be divided into two classes: the first includes all those which are fluid at the ordinary temperature; while the other includes such as become fluid only when heated, and return again to the solid form on cooling; these are called "masses."

Prussian Blue Fluid.—Glycerine, 1 ounce; methylated spirit, 1 ounce; ferrocyanide of potassium, 12 grains; tinc. perchloride of iron, 1 drachm; water, 4 ounces. Mix together the glycerine, water, and spirit, and divide the mixture into two equal parts. In one part (*a*) dissolve the ferrocyanide, and to the other part (*b*) add the tinc. perchloride; *b* must now be added *very gradually* to *a*, the mixture being well shaken after each addition of the iron solution; keep this fluid in a stoppered bottle, and shake it well before using it. This will form a transparent injection. (Beale.)

Turnbull's Blue.—10 grains of pure sulphate of iron are to be dissolved in an ounce of glycerine, or better still, in a little distilled water, and then mixed with glycerine, and 32 grains of ferridcyanide of potassium in another small proportion of water, and the solution mixed with glycerine. These two solutions are then gradually mixed together in a bottle, the iron solution being added to that of the ferridcyanide, and the mixture ensured by frequent agitation. The deep blue fluid thus prepared must be added to 1 ounce of glycerine, 1 ounce of methylated spirit, and 4 ounces of water, as in the Prussian blue fluid. Dr. Beale considers these proportions very large, and gives the following, which I have not myself found to answer well, the injection, especially

under high powers, being too faint :—Ferridcyanide of potassium, 10 grains; sulphate of iron, 5 grains; water, 1 ounce; glycerine, 2 ounces; alcohol, 1 drachm. The advantage of this injection over Prussian blue is that the colour does not fade in course of time. (Beale.)

Bruckle's Soluble Prussian Blue.—(*a*) Ferrocyanide of potassium, 217 grammes, dissolved in one litre of distilled water. (*b*) Perchloride of iron, 10 grammes, dissolved in 2 litres of distilled water. (*c*) A cold saturated solution of sulphate of soda. Mix one part of *a* with one part of *c*, and mix one part of *b* with one part of *c*, add the mixture *a c* to the mixture *b c*, and allow the mixture thus formed to stand about three hours (longer if necessary), collect the deposit on a filter. Wash the deposit three or four times a day for a week by pouring over it small quantities of distilled water. The washing must be discontinued as soon as the water which runs through is quite blue; and the powder thus prepared must be dissolved in distilled water, and mixed with sufficient gelatine to form a firm jelly.

Dr. Beale's Acid Carmine Fluid.—Carmine, 5 grains; glycerine, with eight or ten drops of acetic or hydrochloric acid, ½ ounce; glycerine, 1 ounce; alcohol, 2 drachms; water, 6 drachms; ammonia, a few drops. Mix the carmine with a few drops of water, and when well incorporated, add about five drops of liquor ammonia. To this dark red solution, about ½ ounce of the glycerine is to be added, and the whole well shaken in a bottle. Next, very gradually pour in the acid glycerine, frequently shaking the bottle during admixture. Test the mixture with blue litmus paper, and if not of a very decidedly acid reaction, a few drops more acid must be added to the remainder of the glycerine, and mixed as before. Lastly, mix the alcohol and water very gradually, shaking the bottle thoroughly after each successive portion till the whole is mixed. This may be kept ready, and very rapid injections made with it. It is without doubt one of the very best fluids ever devised. It is most useful for injecting such lower forms of animal life as insects, shell-fish, snails, and small fishes. Acetic acid is to be preferred to hydrochloric for the purpose of acidifying the solution. The object in adding acid to

carmine injections is to precipitate the carmine, and so prevent it from transuding through the walls of the vessels into which it is thrown.

Asphalt and Chloroform.—Ludwig has recently employed a mass, consisting of asphalt dissolved in chloroform and filtered, for the injection of the bile ducts. The merit of this fluid is, that chloroform, being an extremely mobile fluid, flows readily along the vessels, and that it rapidly evaporates and leaves them filled with a solid black mass.

Berlin Blue.—One or two per cent. solution is especially good for cold-blooded animals, and also for blood-vessels, and bile-ducts; in using the two per cent. solution for the ducts warm it first, as it is then less likely to excite contraction of the biliary ducts.

Alcannin and Turpentine.—A solution of alcannin, or alkanet in turpentine, or in chloroform, is used for injecting the lymphatics. The solution is of a bright red colour. Both the turpentine and the chloroform solutions flow readily. When the latter is employed, the chloroform evaporates and leaves the alcannin in the vessels. (Ludwig.)

Nitrate of Silver for blood-vessels.—If a frog be taken, kill it by stunning it on the head; expose the heart, strip off its apex, and allow it to bleed thoroughly. Push a glass or brass canula from the ventricle into one of the aortæ, and inject a stream of distilled water to wash out the blood with its chlorides; inject one-quarter per cent. silver nitrate solution, allow to remain for eight or ten minutes, and then wash it out with distilled water. The most convenient parts to take are the mesentery and bladder. If desirable to silver also the epithelium covering the mesentery; this is done after injection. In the case of a warm-blooded animal, such as a guinea-pig, the water and the silver solution are both heated to 39° C. The fluids are injected into the aorta. A solution of nitrate of silver may also be injected into the lymphatic gland, areolar tissue, testis, lung, etc., for the fixing and staining of tissue elements.

Muller's Prussian Blue.—Cold flowing blue mixture, made by the precipitation of soluble Prussian blue from a concentrated

solution by means of 90 per cent. alcohol. The colouring matter is thus precipitated in a state of most extreme fineness, and a completely neutral fluid is obtained.

White Fluid.—This is very finely granular, and is capable of being combined with a blue, if it be desired to inject the arteries and veins separately. The salt sulphate of baryta is re-precipitated from a cold saturated solution of 4 ounces of chloride of barium, by adding, dropwise, sulphuric acid. After standing for some time (twelve to twenty-four hours) in a tall cylindrical glass vessel, it is deposited at the bottom. About half the fluid, which has again become clear, is now to be poured off, and the remainder, well shaken up, is to be combined with a mixture of one ounce each of alcohol and glycerine. It is distinguished for its great permeability, and is very good for lymph passages and glandular canals. It may be kept for months without alteration, and should be instantly at hand. The requisite quantity for an injection is poured into a porcelain dish, and it is then ready for use.

Brownish-Red Cold Flowing Mass, which is obtained by precipitation from a solution of the chromate of copper, with ferrocyanide of potassium. Chromate of copper is obtained by digesting equivalent portions of sulphate of copper with chromate of potash, and washing out the brown precipitate. The latter readily dissolves in chromic acid in excess, and may be precipitated from the diluted solution, by means of ferrocyanide of potassium, in the form of an extremely fine brownish-red sediment of ferrocyanide of copper. It may be at once injected, without further addition than the solution of bichromate of potash, which has been formed, and thus, at the same time, serve as a medium for hardening the same. It is very useful for spleen.

Soluble Prussian Blue simply dissolved in water for injection of the ducts of glands, urinary canals, biliary plexuses, and also for lymphatic canals. Ten grains of sulphate of iron, dissolved in 1 ounce of water; 32 grains of red prussiate of potash in another ounce of water, and both carefully combined make a good fluid. If the canals to be filled are very fine, double the quantity of each salt is to be added to each ounce of water. Glycerine may be added if desirable.

Kollmann's Red Mixture is very useful. One gramme of carmine, dissolved in a little water, with 15 to 20 drops of concentrated ammonia, and diluted with 20 c.cm. of glycerine. An additional 20 c.cm. of glycerine is to be tempered with 18 to 20 drops of strong muriatic acid, and carefully added to the carmine solution, at the same time shaking the latter strongly. It may be subsequently diluted by the addition of about 40 c.cm. of water.

Dr. Carter's Carmine.—There are several ways of making this stain, but whichever way may be chosen the greatest care must be exercised in making it a neutral, or slightly acid mass; because, if it be alkaline, it will diffuse through the vessels, and stain the adjacent tissues, and render the preparation completely worthless. The mass had better be slightly acid, but if too acid granulation of the carmine takes place, and the fluid will not be driven into the arterioles, much less the capillaries. Parts injected by a carmine and gelatine mass must be immersed in equal parts of water and methylated spirit, having 1 per cent. of acid in it. Take of carmine 120 minims; glacial acetic acid, 86 minims; solution of gelatine (gelatine, 1 part, water 6 parts), 2 ounces; water, 1½ ounces. Dissolve the carmine in the ammonia and water, with the aid of a gentle heat, and filter; add to this 1½ ounces of *hot* gelatine solution, and mix thoroughly. Add the acid to the remaining ½ ounce of gelatine solution, and drop this into the heated carmine mixture, with constant stirring.

Dr. Stirling's Mass.—Take of carmine 60 grains; strong ammonia, 60 minims; glacial acetic acid, 80 minims (about); gelatine (Cox, or Coignets), 1 ounce; water, q.s. Soak the gelatine in water several hours; pour off the water which is not absorbed after the gelatine is completely swollen up, and melt it in a water bath. Then strain while hot, through flannel, and make up the solution to 2 ounces. Place the carmine in a mortar, and add to it the ammonia and 2 ounces of water, and leave it for 12 hours. Then filter, and add acetic acid drop by drop, stirring all the while, until the ammonia is completely neutralised. As the ammonia becomes faint, the acid must be added very cautiously. So long as there is free ammonia, the fluid is dull red, but becomes a florid, bright colour the moment the ammonia is

neutralised. Now mix the two solutions at a temperature of 40° C. (104 F.)

Dr. G. Sims Woodhead's Mass.—Take of carmine (pure) 4 parts, by weight; liq. ammonia, 8 parts, by measure; gelatine (Cox and Coignet's), 10 parts, by weight; distilled water, 100 parts, by measure. Put the carmine in a mortar, and pour on the ammonia, when an almost black paste will be formed, if the carmine is pure; pour on the water, and set the solution aside to filter. Place the gelatine in a narrow glass jar, and add sufficient distilled water to cover it, and allow it to stand until the gelatine is thoroughly softened. Warm the carmine solution in a pan of water (kept nearly boiling on a gas jet, or near the fire), and add the gelatine; stir thoroughly, and add a 10 per cent. solution of acetic acid, drop by drop, until the alkalinity of the ammonia is neutralised, and the fluid even slightly acid. The point at which this takes place will be recognised by the pungent odour of the ammonia becoming gradually lost, and that of the acid substituted, and the fluid loses its bright carmine, transparent colour, and turns a dull brownish red. With the exception of the change of colour test, I prefer Stirling's method, which, however, is greatly improved by making a diluted acetic acid solution, by adding the acid to 1 or 2 drachms of water, when the pouring to or adding is more easily controlled. It will be noticed that Dr. Woodhead takes a 10 per cent. solution.

Blue Mass.—This is made by adding soluble Prussian blue in place of the carmine. Take of soluble Prussian blue 4 drachms; gelatine, 4 ounces; distilled water, 2 ounces. Treat the gelatine the same as in making the carmine mass, using half the water; then add the Prussian blue dissolved in the other half of the water, keeping both solutions hot, and constantly stirring whilst cooling is going on.

Thiersch's Transparent Yellow. — Requires a considerable amount of care to be exercised in its preparation. It is made as follows:—Take of (*a*) chromate of potash 1 part, water 11 parts, dissolve. (*b*) Nitrate of lead 1 part, water 11 parts, dissolve. Mix 1 part of *a* with 4 parts of a concentrated solution of gelatine (made by washing good gelatine for an hour in distilled water, and

then soaking for 24 hours in enough distilled water to cover the gelatine; heating this gently over a water-bath, and filter through clean white flannel; this should be done each time the injection mass is prepared) in a porcelain jar. In a second jar mix 2 parts of *b* with 4 parts of the gelatine mixture. Carefully mix these two gelatine masses at a temperature of from 25°—32° C., stirring rapidly with a glass rod; then heat in a water-bath to about from 70° to 100° C. for an hour, and filter through flannel. In order to prevent the formation of a sediment, a further heating and filtering may be necessary. (Frey.)

Thiersch's Prussian Blue with Oxalic Acid.—Prepare a cold saturated solution of the sulphate of the protoxide of iron (*a*), a similar one of ferrocyanide of potassium—that is, prussiate of potash (*b*); and thirdly, a saturated solution of oxalic acid (*c*); finally, a warm concentrated solution (2 to 1) of fine gelatine. About ½ ounce of the gelatine solution is to be mixed in a porcelain dish, with 6 c.cm. of the solution *a*. In a second larger dish, 1 ounce of the gelatine solution is to be combined with 12 c.cm. of *b*, to which 12 c.cm. of the oxalic acid solution *c* is afterwards added. When the mixtures in both dishes have cooled to about 25° or 32° C., the contents of the first dish is to be added dropwise, and with constant stirring, to the mixture in the latter. After complete precipitation, the deep blue mixture which is formed is to be heated to 70° or 100° C. for a time, and constantly stirred; finally, it is to be filtered through flannel. The injecting fluid thus obtained keeps well in Canada balsam. The depth of its colour may be readily modified to any desired degree by adding a larger quantity of the gelatine solution. (Frey.)

Seiler's Carmine Gelatine.—(*a*) Best carmine, 2 drachms; distilled water, 3 ounces; strong liquor ammonia, 20 drops. Dissolve this and filter, covering the funnel with a piece of glass plate to prevent the evaporation of the ammonia. (*b*) Cox's gelatine, 2 drachms; distilled water, 2 ounces. Soak the gelatine until soft, then dissolve it in a water-bath, and strain through fine flannel while hot. Heat the gelatine solution again, and add the carmine solution. Bring the temperature up to 100° F., and add dilute acetic acid, drop by drop, under constant stirring, until the

ammonia is neutralised, or until the solution changes from a lilac to a scarlet colour.—N.B. Keep a good supply of injections ready in vessels convenient to heat, having wide mouths for the syringe to enter. Occasionally filter to remove any particles of matter which may get into them, see that they are labelled distinctly, and ever clean, and in good order.

Half-an-Hour at the Microscope
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Longitudinal Section of Alder (Pl. III., Figs. 1—6).—The section from which the drawing was made was taken from near the surface, and hence shows the numerous *medullary rays*, which are lines of cells, wedge-shaped in transverse section, proceeding horizontally to the surface; their purpose is to keep up vital connection between the inner and outer structure. On examining a section we see well the division of the bark into its three component parts—outer, middle, and inner. The outer bark, or corky layer, is protected, in young branches, by a single thickness of cells, which occasionally possess stomata—the "epidermis"; the middle layer is composed of cells containing chlorophyll, to which the green colours of this part is due. The inner layer is called the "cambium region"; it is here that in its ascent and descent, new structure is continually being formed. Between the middle and outer bark is the "fibrous layer"; in the alder crystal-prisms occur here, and cells having a very close resemblance in their structure to bone, and scarcely to be distinguished therefrom, save by the presence of the surrounding cell-wall. "Bone-cells" of this kind are not common in wood; indeed, I do not, whilst writing, recall another instance of their recurrence in that part; they form the structure of the stones of fruits, such as the cherry, which presents them in great perfection, and the shells of nuts; the outer husk of hemp-seed, and the gritty substance of pears, furnish good examples of the structure.

An interesting condition of the pitted ducts is present in the alder—that is, continuous bars across, forming an approach to scalariform tissue, which is so strikingly shown in an oblique section of *Pteris aquilina*.

On examining fresh alder-wood, the interesting fact was found that sphæraphides occasionally replaced the prisms in the bark of

this tree, as has been noticed in some other cases by Professor Gulliver.

It is important to remember that the two divisions of nature—the animal and the vegetable—form parts of one continuous whole, and that a good acquaintance with plant organisation is essential to the study of the problems involved in animal life.

Red Earth-Mite (Pl. IV., Figs. 1—9).—I have a slide of this, purchased under the name *Trombidium holosericeum*, and have not yet examined further to see if this name be correct. "The species are numerous and not well characterised." ("Micro. Dict.," *sub.* TROMBIDIUM.) It is very common in my garden in summer, and seeing this slide makes me ashamed not to know more about it. The antennæ-like organs are called "palpi"; their structure is peculiar, the penultimate joint having the form of a powerful claw, which denotes raptorial habits; the last joint is pyriform and fleshy. "The cheliceres (mandibles of some authors) are cultrate" (Siebold and Stannius, Vol. I., p. 376). Look what formidable weapons they are! Like a Malay "crease;" that of the left side has the blade broad, and its edge jagged with saw-teeth; its companion is narrower, more pointed, and apparently nearly smooth on the edge. There is a labium, plumose at the extremity. The hairs to which the velvety appearance is due are of two well-marked types—the one like tiny feathers, the other like little clubs. The clubbed hairs occur on the hinder part of the upper abdominal surface as six radiating bands. They clothe the whole of the under surface. They are seated on transparent cylindrical papillæ, and by looking for some of the latter, where a sectional view is presented, are seen to have a dozen short hairs radiating from their bases. The cutting away (as it might be termed) of the ends of the limbs to accommodate the claws strikes me as a highly curious mechanical arrangement; its purpose being to prevent the sharp tips needed for seizing and holding their prey from being worn. I have not specially looked, but have little doubt they walk, as it were, on the heel and wrist joints. A similar arrangement is met with in Ticks. Flies when walking over rough surfaces, where their pads are not required, draw them back, and then, like most beetles in similar circumstances, hold by the claws alone.

Skin of Small Spotted Dog-Fish, Scyllium Caniculum (Pl III., Figs. 7—11).—This, in addition to its exquisite beauty, is a most instructive specimen. Have you read and pondered "Huxley on the Study of Natural History," a lecture on Zoology, delivered at the South Kensington Museum in 1860, reported in *Science Gossip* for April, 1867, p. 73? If not, I would like you to do so before reading another word of these remarks, or you cannot properly

appreciate the present slide. You will see therein, set forth as it has never been before, how the thoughtful study of a single natural object opens up ever-widening views of the mystery we term "LIFE," with all its various and complicated relations. The subject chosen for the lecture is "But a Lobster"! "The commoner the object the better" is the remark of the Professor. Passing the lobster briefly in review, the external tegumentary skeleton is first examined—ring by ring, limb by limb. To learn how these came to be as they are involves the consideration of development as well as the study of surrounding conditions. Then, after allusions to the modes of grouping necessary to evolve order out of what would otherwise be but a chaotic assemblage of detached facts, as to name, species, genera, orders, representative forms, etc., come considerations of the lobster as a living creature, with the adaptations found in the various parts, fitting one to the other. The motor powers come next under review, as muscles, nerves, and so on—the physiological lessons to be learnt—the geological cousinships to be traced out, involving considerations of all bearing on the subject—until at last he feels compelled to exclaim, on viewing the widely ramified bearings even of so simple a subject: "Truly it has been said, that to a clear eye, the smallest fact is a window through which the Infinite may be seen," and concludes with the following peroration:—"There is not a fragment of the organism of this humble animal, whose study would not lead us into regions of thought as large as those which I have briefly opened up; but what I have done, I trust, has not only enabled my readers to form a conception of the scope and purport of Zoology, but has given an imperfect example of the manner in which, in my opinion, that science, or indeed, any physical science, may be studied. The great matter is to make the study real and practical, by fixing the attention on particular facts; but, at the same time, it should be rendered broad and comprehensive, by constant reference to the generalisations of which all particular facts are illustrations. The lobster has served as a type of the whole animal kingdom, and its anatomy and physiology have illustrated for us some of the greatest truths of biology. The student who has once seen for himself the facts which I have described, has had their relations explained to him, and has clearly comprehended them, has so far a knowledge of zoology, which is real and genuine, however limited it may be, and which is worth more than all the mere reading knowledge of the science he could ever acquire. His zoological information is so far knowledge and not mere hearsay."

In such a spirit alone can we properly attempt to read the choice preparation now before us. The small spots which give a name to the creature are best seen with the naked eye, as also the

"glittering sheen" of the scale-armour. With the lowest power (the 4-in. glass) a good general idea is obtained; the scales then have a general resemblance to those of some fossil fish. View it as an opaque, then as a transparent object, and see how very different it appears. Then put on the 2 in. glass—with a general resemblance see the individual difference between all the scales, no two are alike—so that after a little practice the eye can readily separate any one, and discriminate its special characters. With the ⅔ object-glass and "A" eye-piece, observe the surface of particular scales first, with their ridges increasing in number and elevation as the scale becomes larger and (we must suppose it) older. An arch of lighter colour, probably a canal, can be seen internally, stretching forwards between the first lateral ridges, with a branching canal on either side, passing from the arch to the cusps. Through these nutriment is conveyed; life and continued growth are rendered possible. Turn the slide, so that right and left are reversed, and see how wonderfully like a tooth is each scale! There are fossil-shark's teeth which, in their natural size, closely resemble these scales when magnified to fifty diameters. Now, by focussing down, a view is obtained of their mode of implantation into the skin, by processes resembling for each scale a star of four rays. And see how closely the scales are interlocked! each has six others to support it. The small scattered spines of the Thornback skate are supported by processes forming a *six*-rayed star. Placed at a distance over the surface of the skin, they would appear to require, each individually, the firmer hold gained by having six roots instead of four. Now, supposing what we have before us, after lying in water sufficiently long to decompose the skin and softer parts, and separate the scales—that the outer, harder portions of the latter become fossilised. What is there then to distinguish the so tooth-like scales from teeth proper? Absolutely nothing! The careful study of the context can alone prevent grave errors from being fallen into. T. P. Barkas, in his admirable monograph on coal-measure (Palæontology) has a figure (158, pl. 4), respecting which he says (page 44 of text): "I have considerable doubt respecting their dental character; they may be dermal spines rather than oral appendages." And on looking at a section of "Tooth of Ctenoptychius," in a set he has kindly allowed me to inspect, I am so struck by the absolute resemblance between the microscopic characters of this so-called "Tooth" and some specimens now well recognised as being dermal scales *(though formerly described as teeth!)* that I turn to Barkas for information, and there find under "Ctenoptychius":—It is assumed that these fossils are teeth, or true oral appendages, but so far as my observation has gone, I have not found any in consecutive order. They may be

labial or dermal appendages rather than oral, but in the meantime they are recognised as true teeth.

Professor Owen described *C. pectinatus* as *Ageleodus diadema*. The author of an important paper on the subject, which was laid before the Odontological Society of London, appears to have fallen more than once into the error here pointed out, his knowledge having been acquired simply by examining prepared sections. (See Hancock and Atthey on "Remains of Reptiles and Fishes in Northumbrian Coal Shales," in *Nat. His. Trans.*, Northumberland and Durham, Part I., Vol. III., pp. 85—118). Insight into development of the scales—pigment and its changes—which (when viewed in connection with inflammation, the changes involved therein, and their treatment) involve subjects which must not even be glanced at here. All this, and more, may be learnt from the study of the simple specimen before us. I want you all to learn to read a slide like a book.

Parasite of Vulture.—The Bearded Vulture is named by Denny as being one of the habitats of the Louse common to the *Falconidæ*. He gives a very interesting account of the habits of the creature under *Colpocephalum flavescens*. (M.A.B., p. 206; Pl. XVIII., Fig. 2.) A young Harpy Eagle, in the menagerie of the Earl of Derby, at Knowsley, afforded him ample opportunities for the study. The bird was noticed not to be moulting kindly; it eventually died. The hollows of the large quill-feathers were found filled with specimens of the insect, in all its stages, both in the living stage, and an accumulation of hundreds of cast skins. They appear to have selected this retreat for performing the important operation of ecdysis, as we know do many crustacea in the like circumstances. Two circular apertures, situated near the base of the quill (seat of its blood-supply) afforded the animals access to the interior. The strong stays for the jaws to work on, here flattened from their nearly vertical position (and which must not be mistaken for a second pair of jaws), the peculiar four-jointed antenna, the remarkable eye-lashes, the maxillæ, the gizzard teeth, and the male organs of generation are the most noticeable features of this object.

TUFFEN WEST.

Selected Notes from the Society's Note-Books.

Tongue of Cricket.—The professional mounts of this object are most beautiful, but certainly do not give one any idea of the

natural appearance of that organ. I once dissected and mounted one, but certainly nobody would think that the two objects were from the same source. Will anyone explain how the thing is done? C. F. GEORGE.

Trombidium Phalangii.—A bright scarlet mite taken from a Harvestman spider, which was infested with this parasite, its colour causing it to show very conspicuously, sticking about the body and long legs of the trombidium. The mite, having but six legs, is no doubt a young one, and would have acquired another pair had he lived to grow a little older. The curious feathery hairs are worthy of notice. THOS. BALL.

Tongue of Cricket (Pl. V., Figs. 1–4).—I should say that the lines on the tongue are minute channels, or gutters, kept open by half-rings. This is what occurs in a blow-fly's mouth. I have carefully examined this slide, but I cannot satisfy myself that such is the case in this tongue.

Is this really the tongue? Insects have a true tongue, but as often as not the lower lip is called the tongue. Unless one could see the organ *in situ*, there is little to show whether it is the tongue or the lower lip, minus its base and its palpi. I think, however, it is the tongue, although very unlike the tongue of a grasshopper or field-cricket.

It is a good plan to mount all the six parts of the mouth (dissected) on one slide. A good series of these is very interesting and instructive. H. M. J. UNDERHILL.

Parasite from Ostrich (Pl. IV., Fig. 10) bears a very close resemblance to that from a finch, drawn by Mr. West (Pl. XXIII., Vol. II.). The extraordinary forms which different parasites, apparently nearly allied to each other, assume, are very interesting. Great development of a pair of legs in the male (as in the present instance) is frequent, but usually the second and not the third pair are thus altered. H. M. J. UNDERHILL.

Tongues of Crickets.—I have attempted to mount these, and find that after squeezing out fatty matter (I keep them in gin), there is a *bag*, or perhaps it is an upper and under skin, and I believe it is the upper skin which has all the capillary tubes in it. The lower skin seems to prevent the spreading flat of the upper one. I have tried to tear the tongue open and to clear away the under skin, but have not yet succeeded in that plan. I open the tongue by putting it on a piece of glass with methylated spirit, and place upon it a piece of thin cover-glass, which I move about, but the manipulation is not easy to describe. In dissecting a

cricket's mouth, it is interesting to observe the way the tongue is folded up and put away. I think the capillary tubes are like those of a fly's tongue. But in Wood's "Common Objects of the Microscope," it is said that the triangular lines in the tube are formed by triangular plates instead of rings. My idea is that the liquid food of such insects as flies must be sucked up by the tongue, and probably tasted by means of these tubes. I do not think the fluid goes up the tubes. W. LOCOCK.

Cricket's Tongue.—This specimen shows its 430 springs (for such I take them to be) clearly; at the same time it gives no idea of its natural appearance. A. NICHOLSON.

Tongue of Cricket.—Replying to the above query of Mr. H. M. J. Underhill, I am able to say from my own observation that this is the true *tongue* of the cricket, a fleshy organ which lies within the labium, and is, as Westwood remarks, p. 441, "quadrilobed, the two middle lobes being very slender, and the two external ones broader and pilose, articulated both at and near the base." I give a drawing of his figure of the labium, together with one illustrating the details shown by the slide. The organ certainly calls to mind the membranous, channelled lobes which terminate the proboscis of the *Muscidæ*, and I think it must have a similar function. If so, we may remark how correspondence of parts in different insects involves no necessary correspondence of function, for the office which in the fly devolves upon the expanded extremity of the labium is in the cricket assumed by the tongue—an organ whose homologue in the former insect is a lancet-like, tubular organ of totally different appearance and use. I have given two small drawings of the channels as seen with a quarter-inch object-glass, one taken near their finer extremities and the other from one of their main trunks. A. HAMMOND.

Leaflet of Aspidium (Pl. VI., Fig. 5).—The organs of reproduction (sori) on the under surface of the fronds of ferns are either naked or covered with a delicate membrane (indusium). In Aspidium the indusium covers the sori like a cap, which splits round the edge when the sori are ripe. The sori are made up of numerous oval bodies (sporangia), composed of brownish cells, one of which has thick walls and forms a ring (annulus) round the edge of the sporangium. When ripe, the annulus splits, the spores in the sporangium shoot out, and begin to germinate, putting forth a tubular prolongation (hypha), develop a leafy expansion (prothallus), on the under surface of which the sexual organs—Antheridia (male), Archegonia (female)—make their appearance. H. M. KLAASSEN.

Aspidium.—The indusium in Aspidium (Ἀσπις, a shield) is peltate, attached by the centre; in Nephrodium (Νεφρός, the kidney), kidney-shaped, attached by the notch. H. F. PARSONS.

Young of Anodon cygneus.—These have, I believe, been mistaken formerly for a parasite and described under the name of Glochidium. The young shells show the black cross with polarised light like those of the oyster-spat. This is due to the particles of carbonate of lime, forming the first layer of the young shell, having their optic axes all in the same direction. When, as in the older shell, layer upon layer has been deposited, the particles forming the thin section which we examine have their optic axes pointing different ways, so that instead of the light which passes through the axes of the two Nicol's prisms being totally shut off, rays rotated by particles lying at a different angle come in to take the place of those intercepted, and thus we have a more or less general brightness instead of a dark cross.

H. F. PARSONS.

Burweed (Pl. VI., Figs. 1—4).—When travelling through the wool-producing district of South Africa about two years ago, my attention was directed by some gentlemen engaged in that important trade of the colony to a plant growing there called by the above name; at the same time, they explained the great trouble caused by its seed-pods getting entangled with the wool, and causing much damage to the machinery used in the process of cleaning it. Hence, farmers and land-owners who allow the weed to grow on their land are subject to heavy fines.

I brought home a few of the seed-pods, which are as hard as ebony, and contain two black seeds about the size and shape of grains of wheat. The seed-pods are covered with exceedingly hard, minute, hooked spines. These hooks are so formed as to give the greatest amount of resistance to withdrawal.

On comparing these hooks with those of the common burdock, the latter are not so hard and of a weaker form compared with those of the burweed.

Plate VI. shows the seed entire and in section; also the two forms of hooks. H. N. MAYNARD.

Trichocolea tomentella (Pl. VI., Figs. 6--9).—The cellular structure of this lowly plant shows it to be an apt illustration of the law of association in the vegetable kingdom. Here we see the cells compacted together to form the stem, and branching out to form the leaves which foreshadow the leaves of the phanerogamous plants. It is among the lower orders of plants—such as

confervæ and fungi—that we can more plainly trace the primitive forms of the results of this law. Taking the fungi, and commencing with the unicellular yeast-plant, we follow to *Oidium* and *Penicillum*, where the cells are joined at their ends, then to *Periconia* and *Arthrobotryum*, where they are compacted into a common stem, and so on to the Agarics, which are considered the highest form of fungi.

There is a very interesting article in the *Popular Science Review*, April, 1880, showing the application of this law to the Animal Kingdom, especially as regards the Polypes.

This law, which accounts for the cellular structure of plants, lends additional interest to the study of Botany. W. C. TAIT.

Trichocolea tomentella.—Liverworts are either stemless, with creeping fronds, or they have leafy stems. The *Trichocolea tomentella* (sub-order, Jungermannieæ) belongs to the latter. It is found in moist places in the west and north of England, Scotland, and Ireland, and is remarkable for the character of its leaves, which are much divided, giving the plant the appearance of an Alga. The roots are simple elongated cells, tubular, white, transparent, scattered in small tufts, and springing from the lower surface of the leafy stems. H. M. KLAASSEN.

EXPLANATION OF PLATES III., IV., V., VI.

PLATE III.

Upper Portion.

Fig. 1.—Longitudinal section of Alder, × 100 diam., showing *o.*, outer; *m.*, middle; *i.*, inner, layer of the bark; *e.*, single layer of cells, the "epiderm;" *c.*, corky layers; *f.l.*, fibrous layer, with its raphides and bone-cells; *m.r.*, medullary rays; *w.f.*, woody fibre; *p.d.*, pitted ducts.

,, 2.—Portion of two pitted ducts more enlarged to show the mode of union, × 200.

,, 3.—End of a pitted duct, showing scalariform-like structure.

,, 4.—"Bone-cells."

,, 5.—"Crystal prisms" in the section under observation.

,, 6.—"Spæraphides," in a section of my own (T. West) preparing.

Lower Portion.

,, 7.—Portion of Skin of Dog-Fish magnified 25 diam., showing various forms of scales, two in process of development, and pigment in part.

Fig. 8.—A scale more highly magnified, showing the outline, the ridges, the arcuate internal canal, and the expanded base.

,, 9.—A scale focussed down to the roots, with portions of six supporting scales.

,, 10.—Longitudinal section, small spine-like scale of Thorn-back Skate, showing the structure like dentinal tubuli.

,, 11.—Transverse section, part of same. (Figs. 10 and 11 are from Micro. Dictionary.)

Drawn by Tuffen West.

Plate IV.

Upper Portion.

Illustrating Red Earth-Mite.

Fig. 1.—Left Palpus, × 50.

,, 2.—Mandibles, or Cultrate cheliceres.

,, 3.—Penniform hair.

,, 4.—Clubbed hair.

,, 5.—One of the clubbed hairs focussed to the upper (outer) rim of the supporting papilla.

,, 6.—End of the second limb of the left-side (L. 2), showing the sickle-shaped claws, and the excision of the joint to receive them when retracted.

,, 7.—Extremity of L. 2 in the Dog-tick (*Ixodes ricinus*) from a specimen in my possession; the mode in which the sucker folds together when not in use is well seen here.

,, 8.—*Argas reflexus*, extremity of L. 2.

,, 9.—Labium with palpi.

,, 9*a*.—Plume of labium more magnified, after Duges. (From Micro. Dictionary.)

Drawn by Tuffen West.

Lower Portion.

,, 10.—Parasite from an Ostrich, *Tyroglyphus*, ♀ viewed from beneath, as an opaque object, × 130.

Drawn by H. M. J. Underhill.

Plate V.

Upper Portion.

Fig. 1.—Tongue of Cricket.

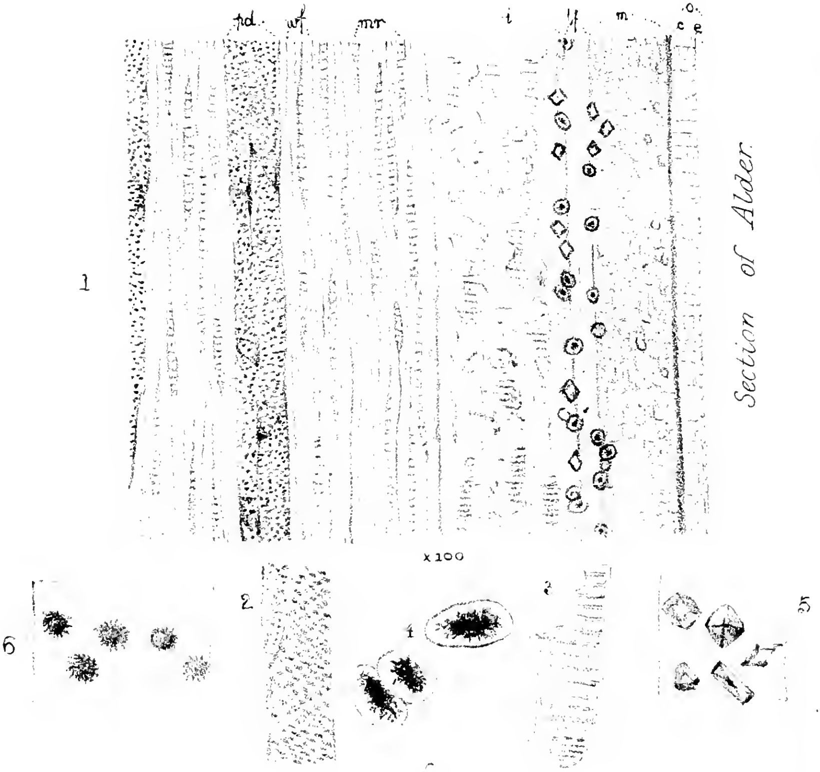
,, 2.—Labium of Cricket, from Westwood, somewhat enlarged.

,, 3.—Portion of the fine extremity of one of the channels, × 350 diam.

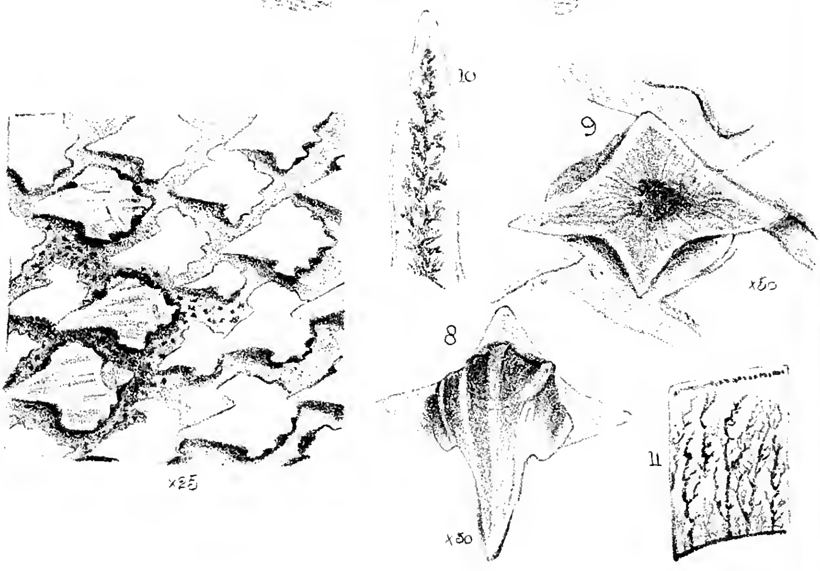
,, 4.—Portion of one of the main trunks, × 350 diam.

Lower Portion.

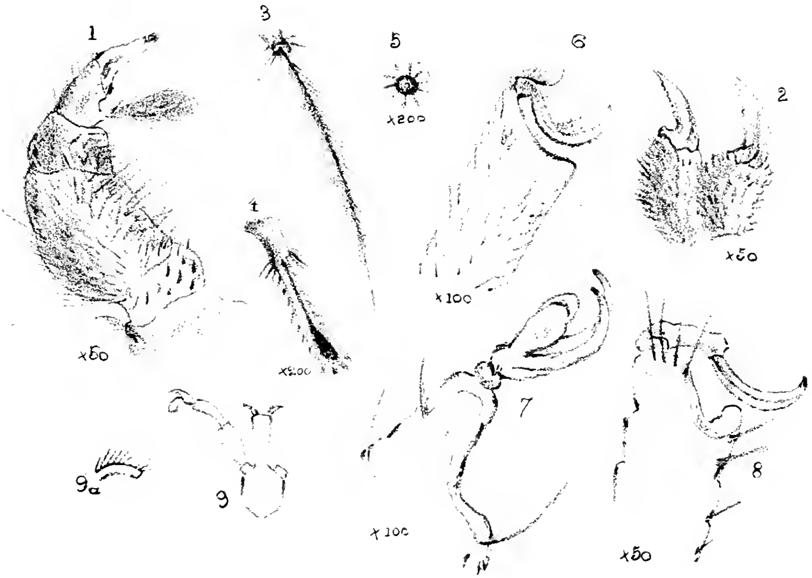
Showing the Homologies of the Dorsal Plates of the Wood-Louse and of the Cockroach.



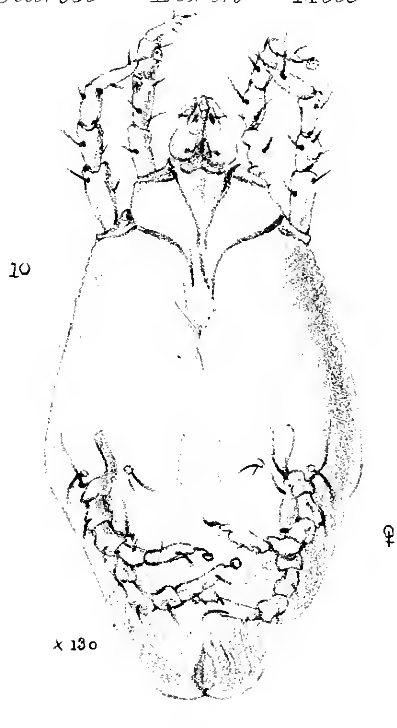
Section of Alder.



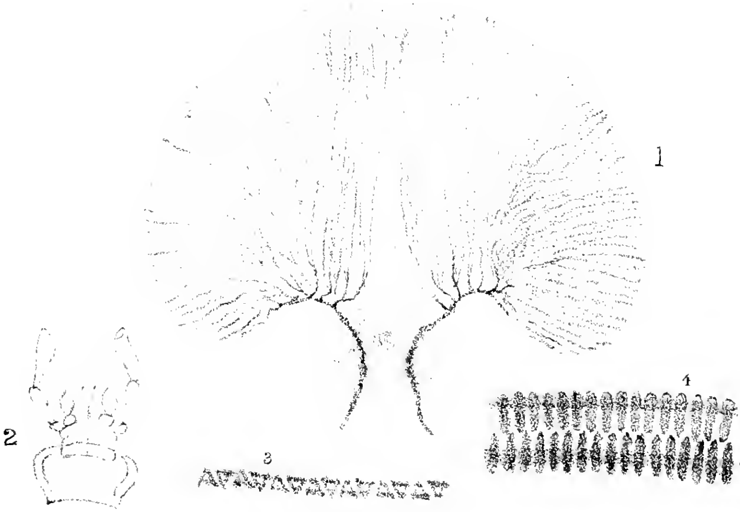
Skin of Dog Fish



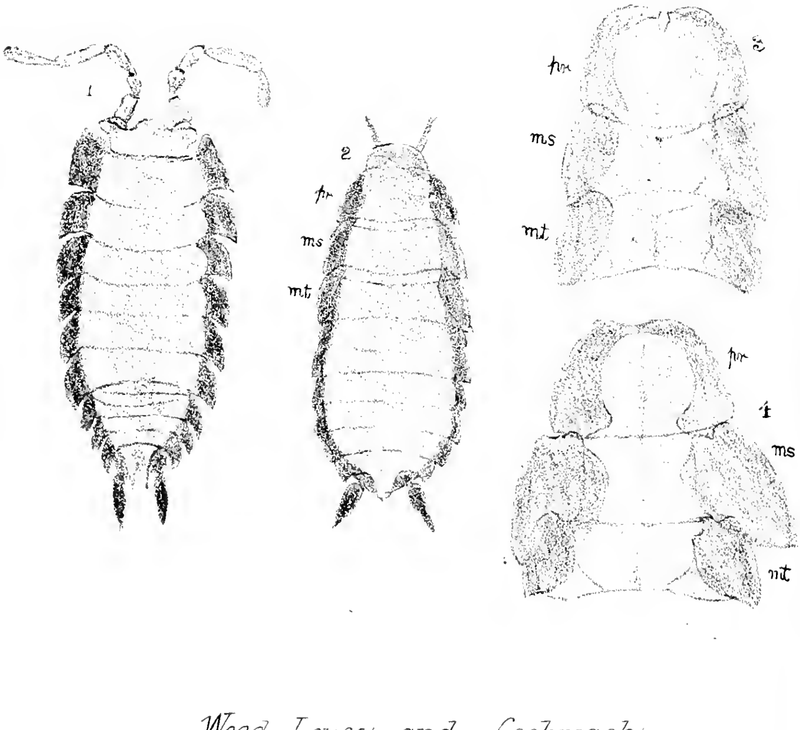
Scarlet Earth Mite



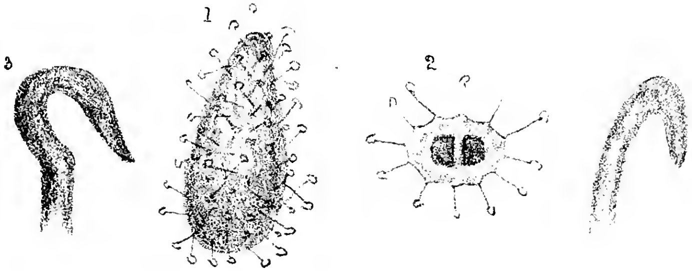
Parasite from Ostrich.



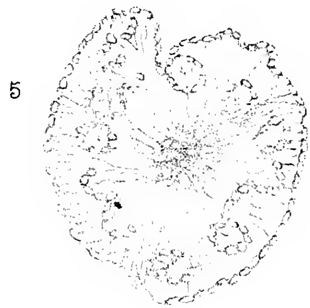
Tongue of Cricket



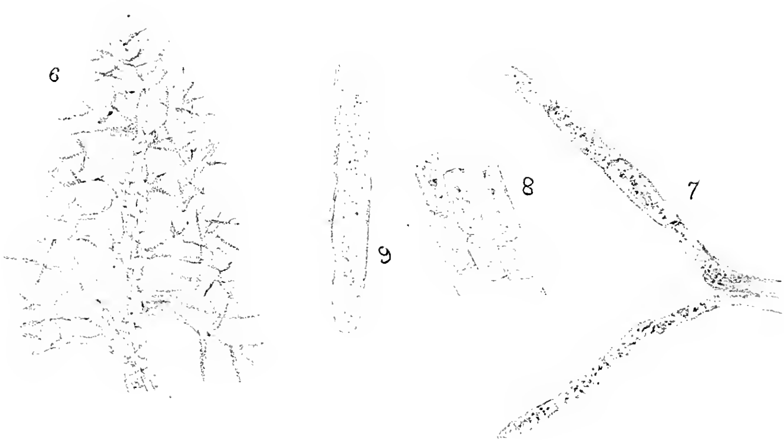
Wood Louse and Cockroach



African Bur-weed.



Aspidium.



Tricholea tomentella

Fig. 1.—Wood-Louse from mounted slide.
,, 2.—Cockroach from same.
,, 3.—The dorsal surfaces of the three thoracic segments of the same in a subsequent stage, the plates not entire, but the lateral portions which form the wings distinguishable upon them.
,, 4.—The same in the perfect female insect, the tegmina fully formed and detached, the posterior wings still remaining an integral portion of the dorsal surface.

In Figs. 2, 3, and 4, *pr.* represents the pro-thorax ; *ms.* the meso ; and *mt.* the meta-thorax. The light-coloured, central portions in these drawings are, I believe, homologous with one another, and the dark colour with the dark colour.

Drawn by Arthur Hammond.

We much regret that the exceedingly interesting article to which the lower part of this plate refers is unavoidably omitted for want of space ; it will appear in our next.—Ed.

PLATE VI.

Fig. 1.—Seed of African Burweed, × 2½ diam.
,, 2.—Section of the same through the centre.
,, 3.—Hook from the same, enlarged.
,, 4.—Hook from British Burdock.

Drawn by H. L. Maynard.

,, 5.—Sorus of Aspidium.

,, 6.—Leafy stem of *Trichocolea tomentella.*
,, 7.—Branching portion of Leaf.
,, 8.—Cells of lower part of Leaf and Stem.
,, 9.—Root Hair.

Drawn by H. M. Klaassen.

Reports of Societies.

[*We shall be glad if Secretaries will send us notice of Meetings of their Societies. Short abstracts of papers read, and principal objects exhibited, will always be acceptable.*]

COUNTY OF MIDDLESEX NATURAL HISTORY AND SCIENCE SOCIETY.

THE first Evening Meeting of the "County of Middlesex Natural History and Science Society" for practical work was held on the 16th Nov., 1886, at the Townhall, Kilburn, nearly 200 members being present.

In the unavoidable absence of the President, the Right Hon. the Earl of Strafford (late Viscount Enfield), Lord-Lieutenant of Middlesex, the chair was taken by one of the Vice-Presidents, Dr. Archibald Geikie, F.R.S., head of the Geological Survey. Mr. Sydney T. Klein, F.R.A.S., Hon. Secretary and Treasurer to the Society, read a paper entitled, "Thirty-six Hours' Hunting among the Lepidoptera and Hymenoptera of Middlesex; with Notes on the Methods adopted for their Capture."

A very enthusiastic discussion followed, in which Dr. Archibald Geikie, Dr. Francis A. Walker, Mr. W. Mathieu Williams, Mr. Basil Woodd Smith, Mr. James Smith, and many others, took part. Mr. Sydney T. Klein, after replying and thanking those present for the cordial way in which they had received his remarks, exhibited in illustration of his paper specimens of the insects referred to, and in addition two queen cells of *Apis Ligustica*, showing how the wax at the apex had been thinned preparatory to the exit of the queen, and the rent in the side of the cell through which the nymph had been stung and dragged forth by the new queen. He also exhibited cells of *Osmia rufa*, the mason bee, from which were released living bees, together with specimens of its beautiful parasite, *Chrysis ignita:* also, specimens of *N. megachile*, the leaf-cutter bee, with its tawny parasite. *Triponylon figulus.* Mr. Klein also exhibited numerous pupæ and cocoons of the species mentioned. Mr. Lant Carpenter showed a portable electric lamp for mining and other purposes; Mr. Rousselet a polyzoon under the microscope; and Mr. Sherborne some artificial "Perlitic" and "Schellerization in rock structures."

A vote of thanks was then passed to Dr. Archibald Geikie, after replying to which he congratulated the Society on the thoroughly practical beginning they had made that night, and brought the meeting to a close.

Reviews.

CHEMICAL ARITHMETIC, with Twelve Hundred Examples. By Sydney Lupton, M.A., F.C.S., F.I.C. Second edition, crown 8vo, pp. xii.—169. (London: Macmillan and Co. 1886.)

A valuable work for students to use in connection with any of the better form of text-books treating of Chemistry and Chemical Physics. It contains questions on Mass, Fluid, Pressure, Heat, Diffusion, Molecular Weights, Solubilities, the Non-Metals and Metals, and at the end a few Logarithmic Tables. The examples are, for the most part, well chosen and of a practical nature.

Dr. F. Beilstein's Lessons in QUALITATIVE CHEMICAL ANALYSIS, arranged on the basis of the fifth German edition. By Charles O. Curt-

man, M.D. 8vo, pp. xii—200. (St. Louis, Mo.: Druggist Publishing Co. 1886. Price, $1.50.)

This is a translation of Dr. Beilstein's "Anleitung," to which the author has made copious additions, including chapters on Chemical Manipulations, Organic Analysis (including Alcohol, the Sugars, Starches, Alkaloids, Albumen, and Urea), Volumetric Analysis, and Analysis of Drinking Water. Though by no means exhaustive, it will be found to contain a large amount of valuable information to the young student.

THE CHEMISTRY OF WHEAT, FLOUR, AND BREAD, and Technology of Bread-Making. By William Jago, F.C.S., F.I.C., Brighton. 8vo, pp. 474. (Published by the author, 138 Springfield Road, Brighton. 1886. Price, 12s. 6d.)

A work containing a large amount of valuable information for the farmer, miller, baker, scientific chemist, and engineer. The author, who is an analytical and consulting chemist, and head master of the Science Schools at Brighton, gives us information on General Chemistry, Microscopy, Fermentation, Bread-Making, Commercial and Analytical Testing, and Adulteration, all well written and thoroughly reliable.

LUNAR SCIENCE: Ancient and Modern. By Rev. Timothy Harley, F.R.A.S., author of "Moon-Lore," etc. 8vo, pp. 89. (London: Swan Sonnenschein and Co. 1886. Price, 3s. 6d.)

We have here a popular and very readable account of facts known about the moon, in which ancient and modern theories are placed side by side. Those who wish to know something about our satellite without dipping too deeply into science will do well to read this little work.

THE ORDNANCE SURVEY OF THE UNITED KINGDOM. By Lieut.-Col. T. Pilkington White, R.E. Crown 8vo, pp. x.—174. (Edinburgh and London: W. Blackwood and Sons. 1886.)

Gives in a popular and interesting manner a very intelligible idea of the great national survey: what it is, how and when it originated, what are its objects, by whom and in what manner it is executed, and who pays for it. The system of triangulation is carefully explained, and all the methods adopted are put before the reader in a very attractive manner.

SOLAR HEAT, GRAVITATION, AND SUN-SPOTS. By J. H. Kidzie. Crown 8vo, pp. xii.—304. (Chicago: S. C. Griggs and Co. 1886. Price, $1.50.)

We have in this volume a new and striking theory with respect to the phenomena of Solar Heat, Gravitation, and Sun-Spots. The author's views are unquestionably his own. On the subject of Solar Heat he tells us that, as there are not less than five or six different theories already advanced by eminent scientists, a new theory cannot therefore be considered as conflicting with any *settled* doctrine on the subject, and that with regard to the *cause* either of gravitation or sun-spots the field is still more completely unoccupied. The work contains upwards of 20 good illustrations.

RUST, SMUT, MILDEW, AND MOULD: An Introduction to the Study of Microscopic Fungi. By M. C. Cooke, M.A., LL.D., A.L.S., etc. Fifth edition, revised and enlarged. Crown 8vo, pp. 262. (London: W. H. Allen and Co. 1886. Price, 6s.)

It is with much pleasure that we welcome a new edition of this valuable little work, which gives in a popular manner a description of those minute

organisms which infest so many of our plants, whether wild or cultivated. Directions are given for collecting, examining, and preserving the various forms of fungi. The book is illustrated with 269 coloured pictures from Sowerby.

Guide to the Recognition of the PRINCIPAL ORDERS OF CRYPTOGAMS and the Commoner and More Easily Distinguished New England Genera, with a full Glossary by Frederick Leroy Sargent. Post 8vo, pp. 39. (Cambridge, U.S.A.: C. W. Sever. 1886.)

A small book, which will be found useful to the student of Cryptogamic Botany, giving a list of the principal genera, with the distingnishing characteristic of each, so that they may be easily recognised. The book is interleaved with blank paper, so that the student may add notes.

POND LIFE: INSECTS. By Edward A. Butler, B.A., B.Sc. Crown 8vo, pp. 127. (London: Swan Sonnenschein and Co. 1886.) Price, 1s.

We are always glad to meet with a new volume of the "Young Collector" series. The one before us is well written, and deals with the subject of pond-life from the surface, middle depths, above the surface, margins, and on water-plants. Hints are given for the collection, observation, and preservation of the insects, and for the breeding of aquatic insects. The engravings are good, and will prove of much interest to the young collector in naming his captures.

LIFE HISTORIES OF PLANTS. By Professor D. McAlpine. Foolscap 4to, pp. 206. (London: Swan Sonnenschien and Co. Price, 6s.)

A valuable book for the biological student, giving a clear view of the comparative study of plants and animals on a physiological basis; the living cell, its principal parts and properties, followed by the life-history of the principal plants in the various stages of cryptogams, from the bacteria to the mosses and ferns, etc. It is illustrated with a great number of very good woodcuts, etc.

GLAUCUS; or, The Wonders of the Shore. By Charles Kingsley. Crown 8vo, pp. xi.—245. (London: Macmillan and Co. 1886. Price, 7s. 6d.)

Perhaps no one is better fitted to speak of the "Wonders of the Shore" than Charles Kingsley, who writes *con amore* of those creatures with whom he has been intimate from childhood. The volume before us is a new edition, beautifully illustrated and handsomely bound, of one which originally appeared some years ago. All who read it will do so with great interest.

OUR ISLAND CONTINENT: A Naturalist's Holiday in Australia. By Dr. J. E. Taylor, F.L.S., F.G.S., with maps. Crown 8vo, pp. 256. (London: The Society for Promoting Christian Knowledge. 1886.)

A delightful little book, giving an extremely pleasing account of a visit to Australia. In a bright and interesting manner the author speaks of the peculiarities of Animal and Vegetable Life, and the geological formation. He visited the museums of Melbourne and Adelaide, and the vineyards of South Australia, and predicts the future importance of the wine trade.

LOG-BOOK OF A FISHERMAN AND ZOOLOGIST. By Frank Buckland, M.A. Fourth edition; illustrated. Crown 8vo, pp. xv.—339. (London: Chapman and Hall. 1883.)

This fascinating book consists of a number of papers selected from *Land and Water* and other magazines. They embrace a variety of subjects connected with Natural History, written in the usual bright style of the author.

Buckland was a universal observer, and it is delightful to read records showing such enthusiasm in whatever he undertook.

———

THE HORSES OF THE SUN: Their Mystery and their Mission. By James Crowther. Crown 8vo, pp. 280. (London: Sunday School Union. Price, 3s. 6d.)

A well written and charming book for young people. Beginning with the ancient myths respecting the sun, and giving an idea of fire and sun worship in ancient times, it carries us on to the real and actual work of the rays of light, or "Horses of the Sun," in vegetation, photography, etc., and without going very deeply into scientific questions, the author gives some startling and interesting facts illustrating the marvellous power of sunlight.

———

LADY BIRD'S TEA PARTY, and Other Stories. By James Crowther. Cr. 8vo, pp. 128. (London: Sunday School Union. Price, 1s. 6d.)

A series of small allegories, drawn from animal, insect, and vegetable life, some of them giving a very clear idea of these lower forms, and evolving from them some amusing and instructive lessons; but the author occasionally confuses himself and his readers by straining the facts to make good the metaphor, as when he mistakes between the neuters and the drones in speaking of a beehive, and representing a banyan of 3,000 years old to be growing in Kew Gardens.

———

PRIMROSES, COWSLIPS, POLYANTHUSES, OXLIPS. By Philanthus. Crown 8vo, pp. 16. Priee, 6d.

THE TOMATO, with Cultural Directions for Maintaining a Continual Supply of the Fruit. By William Iggulden. pp. 73. Price, 1s.

CACTACEOUS PLANTS: Their History and Culture. By Lewis Castle. pp. 93. Price, 1s.

MUSHROOMS FOR THE MILLION, with a Supplement. By J. Wright, F.R.H.S. Fourth edition. pp. 126.

ORCHIDS: Their Structure, History, and Culture. By Lewis Castle. pp. 106. Price, 1s.

In the notice of the above series of valuable little books we have discovered that by error, which we much regret, they were accredited to the *Journal of Agriculture* instead of *The Journal of Horticulture*, office, 171, Fleet Street, E.C.

———

STUDIES IN MICROSCOPICAL SCIENCE. Since our last issue we have received Nos. 3 and 4 of this important work. The subjects considered are:—Section 1, Botanical Histology, Studies in Vegetable Physiology. Chap. 3, a Bifacial Leaf, illustrated by vert. section Leaf of Ivy. Chap. 4, Absorbent Organs, illustrated by a fragment of one of the submerged leaves of *Salvinia natans*. Section 2, Animal Histology. Part 3, the Human Penis. Part 4, the same organ in the Lower Animals; the slides illustrating these being trans. sec. Penis of an Infant at Term × 11 diam., and that of a Dog × 14 diam. Section 3, Pathological Histology treats of the Normal Kidney, and is illustrated by Acute congestion of the kidney. Section 4, Popular Microscopical Studies continues to treat of the Sea Fans, is illustrated by Spines, and plates of *Palmipes membranaceus* and Marine Algæ *Ptilota elegans*. The slides are fully up to the standard of Mr. A. C. Cole's preparations. The studies may be obtained of J. G. Hammond and Co., Edmund Street, Birmingham.

———

THE STUDENT'S HANDBOOK OF HISTORICAL GEOLOGY. By A. J. Jukes-Brown, B.A., F.G.S. 12mo, pp. xi.—597. (London: George Bell and Sons. 1886. Price, 6s.)

One of the series of Bohn's Scientific Library, being a companion volume to "Physical and Structural Geology." The volume before us treats of Palæontological and Historical Geology. In the first division we have chapters on the Geographical Distribution of Life, the Origin and Succession of Species, and the Correlation and Classification of Rocks on Palæontological Principles; in the second division we find twelve chapters which treat of the Azoic Era, Palæozoic Time, and the various systems of Rocks. The book is closely printed and well illustrated, and affords a large amount of information.

GEOLOGICAL STUDIES; or, Elements of Geology for High Schools, Colleges, Normal, and other Schools. By Alexander Winchell, LL.D. Crown 8vo, pp. xxv.—513. (Chicago: S. C. Griggs and Co. 1886. Price, $3.)

The work before us is divided into two parts:—1. Geology inductively Presented; 2. Geology treated Systematically. In the first part the author approaches the elementary facts and conceptions of geology in a pleasing manner from the inductive side. The student is first introduced to the most familiar facts, pebbles and boulders, kinds of minerals and rocks, and such things as may be seen in the fields; then by degrees over the inductive evidences of internal heat, metamorphism, upheaval and subsidence, and thus to the broader generalisations of the science. The second part is a compact systematic review of the subject, bringing into order the matter of the first part, and supplying further information in the several departments. The whole work is handsomely got up, printed on very heavy paper, and is illustrated with 367 engravings in the text.

CHIPS FROM THE EARTH'S CRUST; or, Short Studies in Natural Science. By John Gibson. Crown 8vo, pp. 303. (London: T. Nelson and Sons. 1887.)

We have here, written in very readable language, some interesting accounts of Landslips, Buried Forests, Coal-fields, Fossil Footprints, Diamond Diggings, Gold and Silver Mines, Oil Wells, British Earthquakes, Meteors and Meteor Showers, etc., etc., from which a very valuable knowledge may be gained. The book is nicely bound, and contains 39 plate illustrations.

FUN BETTER THAN PHYSIC; or, Everybody's Life Preserver. By W. W. Hall, M.D. Crown 8vo, pp. 333. (Chicago, U.S.A.: Rand, McNaley, and Co. 1884.)

This is a collection of clever and witty sayings and wise maxims, written by Dr. Hall. Many of the maxims are very good.

SIX LECTURES UPON SCHOOL HYGEINE, delivered under the auspices of the Massachusetts Emergency and Hygeine Association to Teachers in the Public Schools. Crown 8vo, pp. 201. (Boston, U.S.A.: Ginn and Co. 1886. Price, $1.)

Six Lectures on School Hygeine, Heating, aud Ventilation; the Use and Care of the Eyes; Epidemics and Disinfection; Drainage; and the Relation of our Public Schools to the Disorders of the Nervous System; given by different Doctors in Medicine, who were thorough specialists, and adapted their lectures to the distinctive wants of School Teachers. We have read these lectures with much interest.

SPEECHES ON THE IRISH QUESTION IN 1886. By the Right

Hon. W. E. Gladstone, M.P., with an Appendix containing the full text of the Government of Ireland, and the Sale and Purchase of Land Bills of 1886. Revised edition. 8vo, pp. 358. (Edinburgh: Andrew Elliot. 1886. Price, 5s.)

This volume is a continuation of the series containing the Midlothian speeches 1879, 1880, 1884, and 1885, and gives a verbatim report of four speeches on the Government of Ireland Bill—two in April, one in May, and one in June; Speech on the Sale and Purchase of Land (Ireland) Bill; two Addresses to the Midlothian Electors; and five Speeches during the General Election.

NATURAL HISTORY: Its Rise and Progress in Britain as developed in the Life and Labours of Leading Naturalists. By Alleyne Nicholson, M.D., D.Sc. Crown 8vo, pp. vi.—312. (London and Edinburgh: W. and R. Chambers. 1886.)

We have here a general outline of the rise and progress of the Science of Natural History in Britain. This is given in a series of biographical sketches, but as some of the most important steps in the development of the Science of Zoology have been effected by foreign investigators, it was found necessary to some extent to pass beyond the limits of our own country. The work commences with the Aristotelian period; then gives an account of Ray and Willoughby and their work, Linnæus and his classification, the great Museums of Britain, etc. etc., and concludes very naturally with Darwin and his famous works. It is beautifully illustrated with plate and other engravings.

EMINENT DOCTORS: Their Lives and their Work. By G. T. Bettany. M.A., B.Sc., F.L.S. Two vols. Crown 8vo, pp. viii.—311; vi.—318. (London: John Hogg. Price, 12s.)

In these two volumes we find biographies of some of those men who have raised the professions of medicine and surgery to the high position which they occupy at the present time. We find accounts of Harvey and the Circulation of the Blood, Hunter and the application of Anatomy and Pathology to Surgery, Jenner and Vaccination, etc. The subjects are well chosen, and the books will be found instructive and entertaining, both to the medical professor and to the general reader.

MASTER MINDS in Art, Science, and Letters: A Book for Boys. By W. H. Davenport Adams. (London: John Hogg. Price, 4s.)

The author has brought together in three groups men who have distinguished themselves in the fields of Art, Science, and Letters—Reynolds, Constable, Turner, and Haydon; Murchison, Faraday, and Darwin; Sir Walter Scott, and Charles Kingsley; and in telling their story has elucidated the principal features of their character, and the special distinction of their work. This is one of the books that every boy should read.

POST-NORMAN BRITAIN: Foreign Influences upon the History of England from the Accession of Henry III. to the Revolution of 1688. By Henry G. Hewlett. 12mo, pp. 323. (London: Society for Promoting Christian Knowledge. 1886. Price, 3s.)

This is one of a series of volumes, published under the title of "Early Britain," andc ontains a sketch of the various influences derived from foreign sources, which contributed to modify and develop our national character down to the period when our modern History of England may be said to begin.

ANALYSIS OF THE ACTS OF THE APOSTLES. By Lewis

Hughes, B.A., Assistant-Master of Bath College. Parts I., II. Crown 8vo, pp. 221 (Bath: Hallett. London: Hamilton, Adams, and Co. 1886. Price, 2s. 6d.)

Chiefly intended for candidates preparing for the Oxford and Cambridge Local, and the College of Preceptors' Examinations. Mr. Hughes goes fully into the question of the Authorship of the Acts, the time and place of writing, the geography of the places mentioned. The book is divided into numbered sections, each section comprising a paragraph of the Acts, all difficult expressions being carefully explained. A coloured map shows the missionary journeys and last voyage of the Apostle Paul. We find no other map, although the title says "with maps."

FOUR THOUSAND GERMS OF THOUGHT. By Rev. W. White Andrew, M.A. Crown 8vo, pp. xxvii.—286. Edited by Rev. Samuel Smith. (London: Nisbet and Co. 1886. Price, 3s. 6d.)

The subjects of the Germs of Thought are arranged under various headings in alphabetical order—*e.g.*, Acceptance, Adoption, Affliction, Almsgiving, etc., each being founded on certain texts of scripture. In addition, a list of the texts from which the Germs are extracted are given in the Index, and occupy no fewer than 20 pages of small type.

JACK HOOPER: His Adventures at Sea and in South Africa. By Verney Lovett Cameron, C.B., D.C.L., Commander in Royal Navy, etc. Crown 8vo, pp. 348. (London: Nelson and Sons. 1880. Price, 5s.)

This is one of the most charming boy's books which we have read for a long time. Jack, who, with his fellow-apprentice, attempted a voyage in a leaky boat, was picked up when on the point of drowning by a gentleman going on a sporting expedition to South Africa. Here they hunted and shot lions, tigers, hippopotami, etc. etc. He was taken prisoner in a battle with the Boers, but escaped and regained his friends, and on his voyage home was, with his friend and a young lion which he had tamed, deserted on a burning ship, from which he escaped on a raft. The story is of thrilling interest throughout. It is illustrated with 23 full-page plates.

CHANGING PLACES; or, Wilton Fairleigh in Animal Land. By Gertrude Jerdon. Crown 8vo, pp. 144. (London: S. W. Partridge and Co.)

A most amusing tale, in which we are introduced to the *Anthropological Gardens*, kept by the animals in which men who have been cruel to animals are the exhibits. It is very nicely illustrated.

MONSTERS OF THE SEA: Legendary and Authentic. By J. Gibson. Crown 8vo, pp. 138. (London: T. Nelson and Sons. 1887. Price, 1s. 6d.)

Gives a nice account of some of the strange sea animals, such as the Octopus, the Squid, Cuttle fishes, etc.; in addition, such information as is known of Sea-Serpents, etc. It is well illustrated.

QUEER LITTLE FOLKS. By Harriet Beecher Stowe. Crown 8vo, pp. 122.

A DOG'S MISSION; or, the Story of the Old Audrey House. By Harriet Beecher Stowe. Crown 8vo, pp. 146.

Our Dogs and other Stories. By Harriet Beecher Stowe. Crown 8vo, pp. 123. (London, Edinburgh, and New York: T. Nelson and Sons. 1886—7. Price, 1s. each.)

These are very excellent books for young people. The stories are well told, and cannot fail to afford both interest and instruction. The illustrations are good, and being in outline are well suited for colouring by the young artist after reading the books.

Birdie and Her Dog. By E. C. Phillips. With other Stories of Canine Sagacity. Crown 8vo, pp. 96. (London: S. W. Partridge and Co. Price, 1s.)

A story of much interest, showing the strong affection and sagacity of the dog. Our young friends will read this book with much pleasure. The illustrations are numerous and very pleasing.

The Handy Dictionary of Cookery, containing about 500 valuable Receipts. By Mary A. Everard. Crown 8vo, pp. 195. (London: Jas. Nisbet and Co. Price, 2s. 6d.)

Mrs. Everard endeavours here to show how cookery may be made easy. The recipes are given as simply, clearly, and in as few words as possible. The different dishes are arranged in alphabetical order for easy reference.

Three Courses for Threepence: A Series of Lessons on Cottage Cookery, with Appendix on Self-supporting Cookery Classes. By J. R. Richmond. Preface by E. Crewys Sharland. 12mo, pp. 60. (London: Society for Promoting Christian Knowledge. 1886. Price, 4d.)

We feel that we can strongly commend this little book to the notice of our readers. The illustrations are simple and concise, and the dishes appear very palatable.

The Boys' and Girls' Companion: An Illustrated Magazine for Boys and Girls. Crown 4to, pp. 192. (Price, 1s. 6d., 2s.)

The Boys' and Girls' Picture Book. 4to, pp. 96. (London: Church of England Sunday School Institute. 1886. Price, 1s. 6d., 2s.)

The first is the annual volume of the Boys' and Girls' Companion, published monthly during 1886. The second is a very entertaining reading book for very little children. Both are bound in gaily coloured picture-boards, and both are splendid books for the little ones.

Every Boy's Annual. Edited by Edmund Routledge, F.R.G.S. Crown 4to, pp. 570. (London: Geo. Routledge and Sons. 1887.)

A book which cannot fail to please the boys, as it abounds in tales of exciting adventure, historical scenes, and a series of papers on the Electric Telegraph. There are a lot of good illustrations.

Young England: An Illustrated Magazine for Recreation and Instruction. 4to, pp. 572. (London: 56, and 60, Old Bailey. Price, 5s.)

"Young England" is one of those weekly magazines which we cannot recommend too strongly to our young friends; the tales are of thrilling interest, in addition to which we notice a series of papers, "Out Among the Flowers," by our friend, Mr. H. W. S. Worsley-Benison; a series of science

chats; a number of prize competitions, etc. etc. We heartily commend the book.

THE BOYS' OWN TREASURY of Sports and Pastimes. By Rev. J. G. Wood, J. H. Pepper, C. H. Bennett, T. Miller, and others, with upwards of 400 illustrations. Foolscap 8vo, pp. 626. (London: Geo. Routledge and Sons. Price, 3s. 6d.)

Boys of the present day appear to be well cared for. The book before us abounds in games and fun of every description, including the keeping of pet animals, Pigeons, Domestic Fowls, British Song and Talking Birds, etc.; and when sent out under the authorship of such names as we find on the title page, we feel that we can safely offer it to all our young friends.

HAND-BOOK OF MINERALOGY: Determination, Description, and Classification of Minerals found in the United States. By J. C. Foye, A.M., Ph.D. 18mo, pp. 180. (New York: D. Van Nostrand. 1886.)

A useful little book for students commencing Mineralogy; the working directions and descriptions are clear and concise. At the end will be found tables, in which the species are arranged according to their chemical composition.

PLATINOTYPE. By Captain Pizzighelli and Baron A. Hubl. Translated by the late J. F. Iselin, M.A., and edited by Captain W. de W. Abney, R.E., F.R.S. Crown 8vo, pp. 63. (London: Harrison and Sons. 1886. Price, 2s.)

Owing to the growing popularity of the Platinotype process the work before us has been reprinted from the *Photographic Journal*, where it appeared a year or two ago. Amongst other subjects it treats of the Theory of the process, the Production of the Platinum Image, Salts of Iron and Platinum, Development of the Platinum Image, Practical Details of the Process, etc. etc. In certain cases the Platinum process undoubtedly offers advantages which cannot be gained by the silver process, and we make no doubt many of our photographic friends will be glad of the opportunity of reading it up.

THE CAMBRIDGE EXAMINER. Vol. VI., No. 9. November, 1886. (London: Swan Sonnenschein and Co. Price, 6d. monthly.)

Contains questions on Religious Knowledge, Geography, English, Roman, Greek, French, and Constitutional History; English Language, Grammar, and Literature; Latin, Greek, French, German; Arithmetic, Geometry, Algebra, and Higher Mathematics; Science, Logic; Theory and Practice of Education, etc. Suitable for students preparing for the various Junior and Senior Examinations of Oxford, Cambridge, and London.

MONOGRAPHS ON EDUCATION: The Study of Latin. By E. P. Morris. Post 8vo, pp. 27. Modern Petography. By Geo. Huntington Williams. pp. 35. (Boston, U.S.A.: D. C. Heath and Co. 1886.)

These Monographs appear in a very convenient and compact form; they are prepared by specialists, and will be found choice in matter, practical in treatment, and of great value to the teachers. These Monographs will shortly be followed by others on Mathematical Teaching, and How to Teach Reading, the price being 25c. each.

THE JOURNAL OF MICROSCOPY

AND

NATURAL SCIENCE:

THE JOURNAL OF

THE POSTAL MICROSCOPICAL SOCIETY.

APRIL, 1887.

Cristatella Mucedo.

By Richard H. Moore.

Plates 8, 9, 10.

In no department of microscopy is there so much that is interesting as in the multitudinous forms of marine and fresh-water life. In one of the basins of the canal which flows through Bath I have been fortunate enough lately to capture specimens of *Plumatella repens* and *Cristatella mucedo*, either of which would furnish abundant materials for an interesting paper; and in the following pages I venture to invite my brother microscopists to a consideration of the latter. While angling last summer, I brought to shore a root of an aquatic weed, and noticing round its stem a gelatinous mass I carried it home for

future observation. Placing it in a zoophyte trough, I was rewarded by a magnificent sight of snowy crests and waving tentacles, which afforded me many a pleasant hour in watching its movements and learning its history. It was purely an accidental capture; but I felt more convinced than before that, live where we may, we have lying all around us ample resources for microscopical study:—

"Where the pool
Stands mantled o'er with green—invisible
Amid the floating verdure millions stray;
These concealed,
By the kind art of forming Heaven, escape
The grosser eyes of man."

The poet, with his "grosser" allusions, has committed wholesale slaughter among microscopists. Some unaided eyes, no doubt, see a great deal more in Nature's cryptic stores than even some microscopical observers; but when, in addition to the trained organs of natural vision, we possess, and can skilfully use, a phalanx of delicately-formed glasses to reveal the beauties of an unseen world, full of Nature's artistic embellishment, which of *us* would not feel traduced by the "grosser" hints of the poet's muse?

Cristatella mucedo belongs to the large sub-kingdom of the MOLLUSCA, of which there are two divisions:—the MOLLUSCA proper, and the MOLLUSCOIDA. In the former division the nervous system consists of three principal pairs of ganglia, with a well-developed heart of at least two chambers, as, *e.g.*, in the class *Gasteropoda*, which includes the Snail and the Whelk. *Cristatella*, however, belongs to the *Molluscoida*, in which the heart is either imperfect or absent, and in which the nervous system consists either of a single ganglion, or of one pair with accessory ganglia. The *Molluscoida* until lately were divided into three classes:—the *Polyzoa* or *Bryozoa;* the *Tunicata* or *Ascidioida;* and the *Brachiopoda*. The latter two are always marine, while the *Polyzoa* comprise both marine and fresh-water species; and *Cristatella mucedo*, with which we are now concerned, is one of the latter.

Bearing in mind, then, that *Cristatella* is placed in the "*Polyzoa*" class of the "MOLLUSCOIDA" division, it will be well perhaps to draw attention first to the points of difference between the *Polyzoa* and the other two classes. The true position of the *Brachiopoda*, which are inclosed in a bivalve shell, seems at present to be doubtful. In the later researches of Professor Allman, as embodied in his monograph of fresh-water Polyzoa, he does not agree with Huxley in considering that certain similarities of structure with the Polyzoa are of sufficient importance to include them in that group, as they have a much nearer relationship to the true Mollusca. But between the *Tunicata* and the *Polyzoa* there is considerable resemblance, for the *Tunicata* (which includes the Ascidians and the Salpæ), like the *Polyzoa*, inhabit a double-walled sac, yet there are two great distinctions between these classes. 1st.—The *Polyzoa* are entirely destitute of heart and blood vessels, the fluid within the perivisceral cavity being clear and colourless, and being kept constantly in motion by internal cilia; while the *Tunicata*, on the other hand, have a distinct though imperfect heart, and the sac-walls are lined with a complete system of blood-vessels. This heart, or circulatory apparatus, differs from that of all other animals in that it is entirely destitute of valves, being a simple tube, beating with measured pulsations that drive the blood first through one end and then through the other, so reversing the currents alternately. 2nd.—The *Polyzoa* are distinguished from the *Tunicata*, inasmuch as the alimentary canal can be protruded and withdrawn by the processes of evagination and invagination. The mouth, with its ciliated tentacula, rises from the body of the creature and unfolds itself in one of the most beautiful forms of animal inflorescence. Whether it be *Plumatella* or *Cristatella*, nothing can exceed the beauty of the long, waving, silver-like tentacles, with their rapidly vibrating, almost indistinguishable, cilia, especially when viewed under a spot-lens with good illuminating power. The *Tunicata*, on the contrary, have no means of protrusion, their movements being wholly carried on within the sac-walls. These two points of variation are well shown in the accompanying diagrams (Pl. VIII., Figs. 3—5), which has been copied from a drawing in Professor Allman's well-known monograph on the Polyzoa. In Fig. 3, the

anatomy of an exserted Polyzoon is shown; in Fig. 4 the same retracted; while Fig. 5 is the typical form of *Tunicata*, with its extraordinary respiratory apparatus, marked G. This consists of a membranous sac, with transverse and longitudinal bars, crossing each other and forming a series of quadrangular apertures, around the interior of which vibratile cilia are placed. At V., the imperfect, heart-like structure is found, and the respiratory organ is connected with it by a system of vessels which bring the blood to the sac for aeration. According to Allman, this respiratory sac is homologous with the tentacular crown of the *Polyzoa* (A., Fig. 3). He considers that the transverse, and not the longitudinal bars are homologous to the tentacles of the latter. The *Polyzoa* are destitute of blood, but its place is supplied by a fluid which fills the whole of the perigastric space, and which extends into the tentacula, having irregularly-shaped particles of matter floating within it. This fluid assumes a constant rotatory motion, probably caused by the internal cilia which are supposed to clothe the sac-walls. No apertures for the absorption of the watery fluid have yet been discovered, and Allman states that he has kept *Cristatella* for many hours in carminated water without detecting any carmine particles within the perigastric space. He is nevertheless of opinion that the interior fluid is purely aqueous, and that by some undetected orifices the water finds an entrance. When there, it serves the triple purpose of a chyliferous, a sanguiferous, and a respiratory system.

Having, thus briefly, endeavoured to show the important differences in the two classes of *Molluscoida*, I shall now confine myself to the *Polyzoa*, or *Bryozoa*, which latter name originates from the Greek "Bryon"—moss, and "Zoon," an animal; the habit of many of this class being to incrust foreign bodies like moss. According to Professor Allman, the *Polyzoa* are divided into two orders: 1st, the "*Phylactolæmata*," or "throat-guarded," so called from a curious valve of a protective nature, which guards the mouth of the creature, and is situated in the crater of the tentacular crown; and 2nd, the "*Gymnolæmata*" or "naked-throated," where no such appendage exists. The first order includes all the Fresh-water species excepting *Paludicella*, but none of the marine except *Pedicellina*. The 2nd order is made up

of species which are mostly marine. The first order, in which *Cristatella* is found, has also been named *Hippocrepia*, by reason of the tentacular crown being, as the name implies, of a horse-shoe shape; the second order is sometimes named *Infundibulata*, because the tentacular crown is "funnel-shaped." By much the largest share of attention has been given to the marine species of the second order. Books treat largely of them and prepared slides are abundant, but Professor Allman, by the publication of his Monograph, in 1856, has given a stimulus to researches among our fresh-water species; and by a careful study of this work, accompanied by exploration in suitable localities, anyone will now be able to add considerably to his own knowledge of the department now under consideration. Our esteemed ex-president, Mr. Morris, F.L.S., possesses some slides of great beauty illustrative of the marine class of *Polyzoa*, the organisms having been killed with tentacles fully expanded; and such slides are of great value. It will be interesting to experiment in a similar way upon specimens of the order in which *Plumatella* and *Cristatella* are placed, so that it may be seen whether the expansions of the lophophores, or tentacular crowns, are capable of preservation. It is possible that as the branch-like expansion in a *Plumatella* is of a somewhat dense, tough material, the open tentacles may be permanently secured; but during last summer I failed entirely to preserve any expanded specimens of the *Cristatella mucedo;* and I fear this is an impossible achievement owing to the gelatinous character of the sac-walls in which these lovely creatures exist. I have copied from Allman's Monograph (see Plate X.) a drawing of a colony of *Cristatella* as they appear in the height of summer, clasping with moss-like tenacity the stems of aquatic plants. I have always, myself, found them in the deeper water, although the writer of a paper in Vol. II. of the "*Popular Science Review*" advises that, in searching for adult specimens of *Cristatella*, you must lie down flat on the bank, carefully remove the floating algæ, and with your eyes close to the surface of the water scan the submerged plants as they grow "in situ," and so secure the specimens. The study of natural history does undoubtedly compel an ardent student to practise all sorts of strange devices in capturing his prizes, and the writer of this paper evidently feels

for such of his readers as take his advice, since he quotes from the "Ingoldsby Legends" to try and comfort those who suffer annoyance in their pursuits from the vulgar stare of unconcerned onlookers. The hero is there described as one who

"Would pore by the hour
O'er a weed or a flower,
Or the slugs that come crawling out after a shower;
Still poking his nose, into this thing or that,
At a gnat, or a bat, or a cat, or a rat,
Or ugly great things,
All legs or wings,
With nasty long tails arm'd with nasty long stings."

But I can assure my readers that nothing of the kind need be indulged in, for I have made very successful hauls of *Cristatella* by drawing the weeds from the water at the end of an ordinary fishing-line. The gelatinous colony is soon recognised, and you have only to bottle it and carry it home for quiet examination with the microscope. The drawing from Allman (Plate X.) is a very truthful representation of the colony as seen in the height of summer, attached to a spray of *Ranunculus aquatilis*. Drawn from the water, the weeds are anything but attractive: the *débris* of decaying vegetation often covers them, and gives a rusty-brown appearance; but microscopists know well that within the bosom of these unattractive, dirty-looking plants, marvellous life is hidden, and as we run our eyes over them here and there the colonies of *Cristatella* are manifested by the slimy, glutinous masses encircling the stems. Place one of these beneath the glass, adapt the spot-lens, and throw a strong light upon it. A world of beauty will soon unfold itself to view. These *Cristatellæ* are the least shy of all their family. A *Plumatella* you must leave sometimes for hours before it will venture cautiously to unfold its tentacula, and the slightest tap upon the stage will suffice to make it snatch them back into their mysterious home; but *Cristatella* loves the light, and almost as soon as one can arrange the glass it floats across the field its snowy, pearl-like arms, and all the water is moved in gentle currents before their enchanting sway. It is life, curious and mysterious, fulfilling its proper destiny subject to Nature's laws. These wonderful creatures

"Enjoy and live like man,
And the minutest throb
That through their frame diffuses
The slightest, faintest motion
Is fixed and indispensable,
As the majestic laws
That rule yon rolling orbs."

The colony, or "cœnœcium," (to use the proper term, signifying "common house,") is not stationary. Unlike some other species it can shift its locality. The whole mass is oval, with a convex upper surface studded with apertures, through which the beautiful zooids protrude. They inhabit the outer margin of the cœnœcium in three regular concentric series of apertures, alternating one with another; the interior oval space is devoid of orifices. This description is according to Allman, and its features can be tolerably well seen in the drawing, copied from his splendid monograph. The under surface of the cœnœcium is stated to be well adapted for the purpose of locomotion, resembling in its central portion the foot of a gasteropodous mollusc. From the longitudinal disc or foot, which is contractile, a large flattened margin extends beyond the external series of orifices; and a regular arrangement of tubes can be seen within the outer membrane, but having no external openings. Towards the end of the season the central upper portion of the cœnœcium is studded with dark circular bodies; these are the "statoblasts," which are destined to form the colonies of the succeeding season, and which have been observed only in *Cristatella* and one other species. They are orbicular, the central portion being surrounded with an annulus of hexagonal cells. The interior and thicker orbicular part is of a rich reddish brown, decorated with dark spots, while the annulus is of a yellowish tinge. In its earlier stages it is surrounded with cilia, afterwards with a membrane; but between the junction of the annulus and the central disc there subsequently grows a number of barbed organs, which lengthen beyond the annulus, and eventually tear up and destroy the outer membrane. No orifice has been discovered in the parent animal by which these statoblasts are expelled, and it is presumed on very good evidence

that they are closely confined within the cœnœcium until the end of the autumn, when the whole colony breaks up and perishes. The liberated statoblasts are then free either to float upon the surface of the water, or, by their extraordinary grappling-iron-like threads, to attach themselves to the water-weeds in their locality. These statoblasts are themselves beautiful microscopical objects, and I have copied their appearance in two positions from Professor Allman's monograph (Plate X., Figs. 3, 4).

While none of the parent animals are ever found during the winter months, the statoblasts weather through the cold and icy days to welcome the spring sunshine—caskets of beauty, ready to open their valves for the discharge of the creature which grows into the colony of the succeeding summer.

They come—

> "From every chink and secret corner,
> Where they slept away the wintry storms."

On the 12th April, 1879, I found one of these embryo colonies of *Cristatella* and the empty valves of the statoblast beside it. It had an irregularly, pear-shaped cyst, with two orifices, through which two lophophores protruded, and for several days I had the pleasure of watching its beautiful movements. It soon died, however, in the zoophyte trough; but on May 1st another appeared, although I had not the good fortune to observe the process of emission. This specimen was particularly active, adhering to the glass slide; it continually changed its shape, and protruded and withdrew its tentacles, now half unfolded, now in full expansion. In two of its stages I made drawings under the tinted reflector (Pl. IX., Figs. 1, 2); and although in the "Micrographic Dictionary" the youthful creature is portrayed in all the symmetry of artistic propriety, my interesting guest never once appeared in so proper an attitude. I expected to see the juvenile *Cristatella* as described in the "Dictionary," and in Rymer Jones's "General Structure of the Animal Kingdom," the one drawing being evidently copied from the other; but instead of this perfection of symmetry, my specimens assumed forms quite different. In the drawings referred to it will be noticed that the statoblast has divided from the apex to the base across the centre of the structure. This, I think, must be an error, as Professor

Allman distinctly states that the young *Cristatella* emerges from between the two discs, and that it may frequently be seen with the separated valves clinging to its sac. I have had several dozen statoblasts in the aquarium during the winter, and the valves in spring separated as described by Allman: I have detected but one that was fractured across the disc, and probably this had been the prey of some hungry larva.

The cœnœcium of the Polyzoa has two distinct membranes:—the interior or "endocyst," and the exterior or "ectocyst." In *Cristatella*, however, the "ectocyst" is entirely absent, the whole cœnœcium consisting of an "endocyst" only, which presents below the curious foot-like appendage already referred to. Owing to the invaginating properties of the endocyst, this inner membrane is highly contractile at its upper extremity, but becomes thinner and less contractile towards the base. The ectocyst, when present, is composed of a tough, brown membrane, and in many of the genera it is additionally strengthened by the adhesion of siliceous and earthy deposits; this naturally obscures the microscopical investigation of many of the Polyzoa. The anatomy of these investing sacs is fully described by Allman, and one of the most interesting portions of his monograph treats of his histological researches into these portions of Polyzoon life. In the genus *Lophopus* the endocyst is composed of irregularly shaped cells, filled with a transparent fluid, and containing nuclei and nucleoli imbedded in the cell-walls: the whole of the interior of the endocyst he has found to be lined with a system of minute canals, and also by a network of fibres, which he has separated from the sac-wall in a continuous layer.

The production and development of the statoblasts is, however, but one method of reproduction, and is confined to the winter stages of this interesting creature. All the fresh-water Polyzoa, according to Allman, have a sexual and a non-sexual reproduction; and he considers that three methods are distinctly observable. 1st—The sexual, by means of testes and ova discerned by himself in the pericardial cavity. 2nd—The non-sexual, by gemmæ; and 3rd—The non-sexual, by statoblasts already described. As the statoblasts are destitute of germinal properties, he considers them to be only a variation of budding or

germination,—the bud being enclosed in the curious but beautiful cyst. We have an analogy to this in the pupa state of some insects, in both cases the animal remaining quiescent through the winter periods. The reproduction through sexual organs, already referred to in sketching the plan of the Polyzoa, has received a large share of attention from the Professor. He says that the testis and ovary are both found within the sac-walls during the months of July and August, and that on the rupture of the testis the spermatozoa float within the perigastric space. They are thread-like bodies in many of the species without any enlargement at either extremity; and floating about with a sinuous motion, they thus are brought into contact with the ovary. Some of the species, however, have spermatozoa with a thickened extremity. The subsequent development is carried on within the perigastric cavity, and eventually it is perfected as a pyriform polypede, swimming merrily with rapidly vibrating cilia through the parent cavity. How it emerges from the sac is a matter difficult to determine, no orifice for its escape having been yet discovered. The second method of reproduction is by gemmæ, or buds, which grow from the endocyst through the exterior surface of the cœnœcium. These appear at first as small tubercles on the exterior surface, filled with granular matter. The tubercle lengthens and expands, and is in its next stage covered with a thick outer membrane continuous with the ectocyst of the parent cell, and having an internal fleshy lining continuous with the endocyst. This latter is full of large, nucleated cells, and the two sacs become the ectocyst and endocyst of the future polypede. The structure gradually developes; the lophophore, retractor, and general muscles are presently formed; the œsophagus, stomach, and intestine become soon distinguishable; but all through this development the future polypede derives all its nutriment from the parent colony. In a little while, however, the process of evagination and invagination is completed, the tentacular crown is perfected, and the young animal then supports its own existence from the outer world. The *Cristatellidæ* produce their gemmæ from points on the sides of the previously existing cells; there is no branch formation, and the colony expands itself upon the surface of the disc, which has been already described, forming

three concentric rows studded with polypedes.

We have to consider, thirdly, the non-sexual reproduction by statoblasts. Those of *Cristatella* I have already fully described. In the Polyzoa reproduction commences from a swelling first seen on the funiculus, or cord, by which the testis is united to the stomach, and to the endocyst at the bottom of the sac. This swelling increases, becomes oval, and is filled with granular matter, which soon developes into minute cells. An external covering is then apparent, also cellular; and very soon the interior cell and the newly-formed ring, or annulus, around it becomes too opaque to observe the changes subsequently wrought. The interior cell becomes of a dark brown, and the annulus of a yellow colour; while the latter is seen to be composed of large hexagonal cells, filled with air. After a time the perfected statoblast separates itself from the funiculus, and falls into the perigastric space, where it remains until the breaking-up of the cœnœcium sets it free. The large cells of the annulus being filled with air, allow it then to float among the submerged plants, or to swim freely upon the surface of the water.

Still another method of reproduction occurs, which Professor Allman treats of under the head of gemmation. In this case masses of buds are developed, and a division at certain points occurs in the whole colony. A constriction may be observed in the cœnœcium, which gradually extends until the colony is divided into two portions, and these move away in opposite directions. The sexual and non-sexual reproduction of the Polyzoa has brought this class within the law of "Alternation of generations," and as Professor Allman's excellent work on the "Fresh-water Polyzoa" is not easily accessible, and as his descriptions cannot well be condensed, I quote from it *verbatim*:—

"We have, first, as the immediate result of the development of the ovum, a ciliated, sac-like embryo, resembling in form and habit an infusorial animalcule. It is a non-sexual zooid. From this is produced subsequently, by a process of gemmation, another form of zooid, namely—the polypede, with a much more highly-differentiated structure, in which the organs of digestion especially hold a dominant position, and which we may regard as sexual or non-sexual, according to the view we take of the relation

between it and the testis, as will presently be seen. Now, if the formation of the ovary be attended to, it will be seen that this body is developed at a late period from the walls of the original, sac-like embryo, which have undergone slight changes, and have become the endocyst of the more mature Polyzoon, and it will at once be perceived that this development of the ovary takes place in a way which may obviously be compared with the formation of a bud ; that at least in *Alcyonella* it occupies exactly the position in certain cells that the buds destined to become polypedes do in others ; and that at an early stage of polypede and ovary it is scarcely possible to distinguish one from the other, so that the idea is immediately suggested that the body here called the ovary is itself a distinct zooid, in which the whole organisation becomes so completely subordinate to the reproductive function as to be entirely masked and apparently replaced by the generative organs. This would then constitute a third zooid, which would therefore be a sexual zooid ; it is, however, unisexual (female).

" In the next place, we find that upon the funiculus (in *Alcyonella),* which probably belongs rather to the polypede than the endocyst, there is developed the mass here described as testis. Now, if we view this mass as a mere organ of the polypede, we must then regard the latter as the second sexual or male zooid, but the testis may perhaps be more correctly considered, like the ovary, as a distinct sexual bud, having the generative system so enormously predominant as to overrule and replace all the rest of the organisation, this bud, like the ovary, being also uni-sexual, but with a male function. In confirmation of this view, it is to be remembered that the funiculus has the power of giving origin to a very remarkable form of undoubted bud—the statoblast—which until ulterior development is excited in it has no nearer resemblance to an ordinary polypede bud than the testicular mass has ; and to this statoblast—in so far, at least, as position is concerned—the male bud or testis in *Alcyonella* would therefore be related just as the female bud or ovary is related to an ordinary polypede bud. In *Paludicella* the testis, though in immediate connection with the funiculus, is developed apparently from the endocyst.

" If the above be the correct view, the complete comprehension of the Polyzoon will involve the conception of a ciliated,

sac-like embryo as a starting-point, and a series of buds, of which the last term will consist of a pair of sexual buds, the others being non-sexual. From the sexual buds a true embryo, like the first, is again produced, which affords the point of departure for another similar cycle."

For my own part, I must confess that this doctrine of "alternation of generations" appears to be very ingenious, but yet may not be true. It depends upon starting with a *perfect*, unisexual zooid. *Is* it perfect? Is it not rather an imperfect polypede, confined within the cœnœcium until it has reached maturity, with digestive and generative organs all complete, and not till then liberated into the outer world? True, the earlier zooid is an *apparently* perfect creature, vibrating its cilia and swimming with rapid movements through the perigastric space; but then it does not leave the parent cell until it has reached the perfection of reproductive faculties. The whole of this interesting question resolves itself into the true conception of the so-called unisexual zooids. If in their extremely minute and consequently undiscovered anatomy they contain the elements of generative organs too minute to be discovered by the most powerful glasses, does not the whole of this system of alternation of generations fall to the ground?

In conclusion, while this paper has dwelt largely upon the one particular family of *Cristatella*, it has necessarily included also the chief features of the class Polyzoa. Anyone who studies the monograph of Professor Allman must be impressed with the very small portion of it which refers especially to the beautiful family of the *Cristatellidæ*. With the exception of *Pectinatella*, the statoblast of this family is unique. The family is also unique in being devoid of ectocyst, or outer sac. It possesses a peculiar under surface, which distinguishes it in a remarkable degree from the other families, and which imparts to it the unique faculty of locomotion, and, so far as I can gather, the reproductive faculties of the family (which contains only one genus, *Cristatella mucedo*) are only to be conjectured from the development of other families. If it does produce polypedes by the resulting spermatozooids of testis and ovary, at what stage of the parent life are they produced? None have been found in the winter months, and

Professor Allman states that the colony is strictly annual. These are enquiries which open up large fields of research in one of the most beautiful and attractive branches of microscopic study. Here alone is summer and autumn occupation for ardent microscopists. The snowy crests of the *Cristatella*, their sweeping tentacles, and vibrating cilia, will charm the eye of student or non-student alike for many an hour. Its beauty of form only will captivate the latter, but to the former belongs the additional pleasure of histological research and of tracing its wonderful life-history.

> "Here, to charm the curious eye,
> A host of hidden treasures lie!
> A microscopic world that tells
> That not alone in trees and flowers
> The spirit bright of beauty dwells;
> That not alone in lofty bowers
> The mighty hand of God is seen;
> But, more triumphant still, in things men
> count as mean."

EXPLANATION OF PLATES VIII., IX., X.

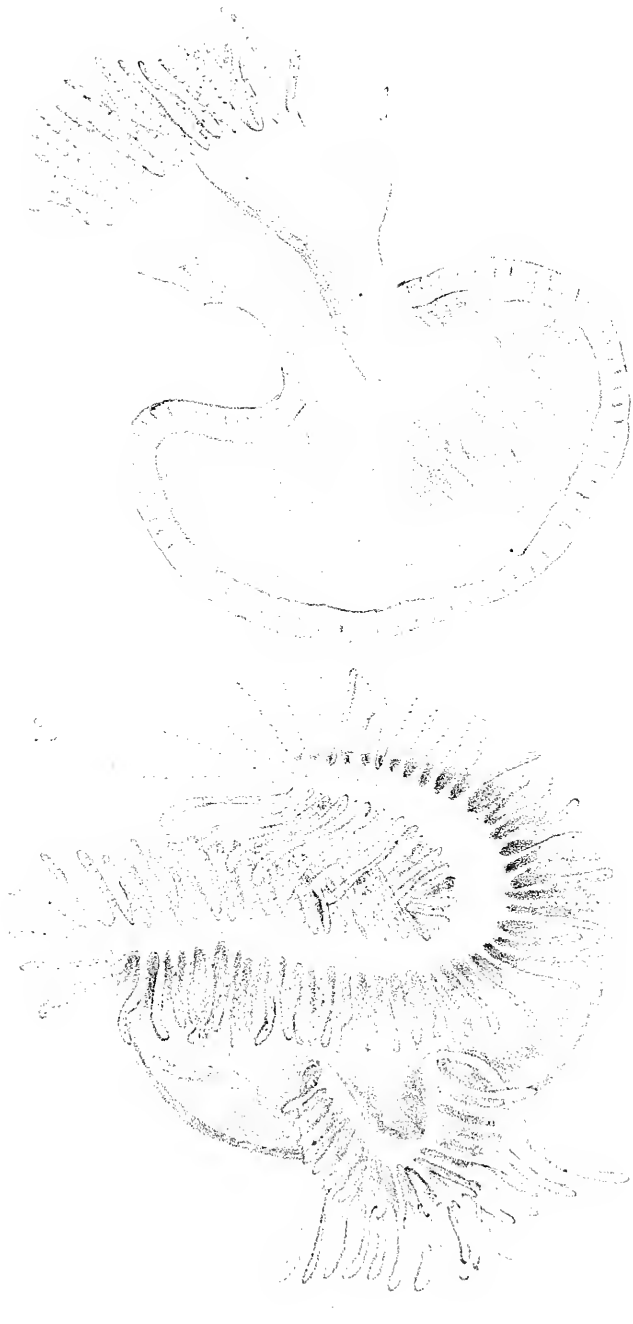
Plate VIII.

Fig. 1.—*Paludicella Ehrenbergi.*
,, 2.—*Alcyonella fungosa.* *a*, ovary; *b*, testis; *c*, funiculus; *d*, spermatozoa.
,, 3—4. Plan of Polyzon, exserted in Fig. 3, retracted in Fig. 4. *a*, mouth and tentacles; *b*, alimentary canal; *c*, anus; *d*, nervous ganglion; *e*, membranous sac; *f*, testis; *f′*, ovary; *g*, retractor muscle.
,, 5.—Plan of Ascidian Tunicate. *a*, external tunic; *b*, middle tunic; *c*, internal tunic; *e*, respiratory orifice; *g*, transverse respiratory bars; *h*, longitudinal respiratory bars; *n*, mouth; *o*, œsophagus; *p*, stomach; *q*, intestine; *r*, anus; *t*, tentacula; *u*, ganglion; *v*, heart.

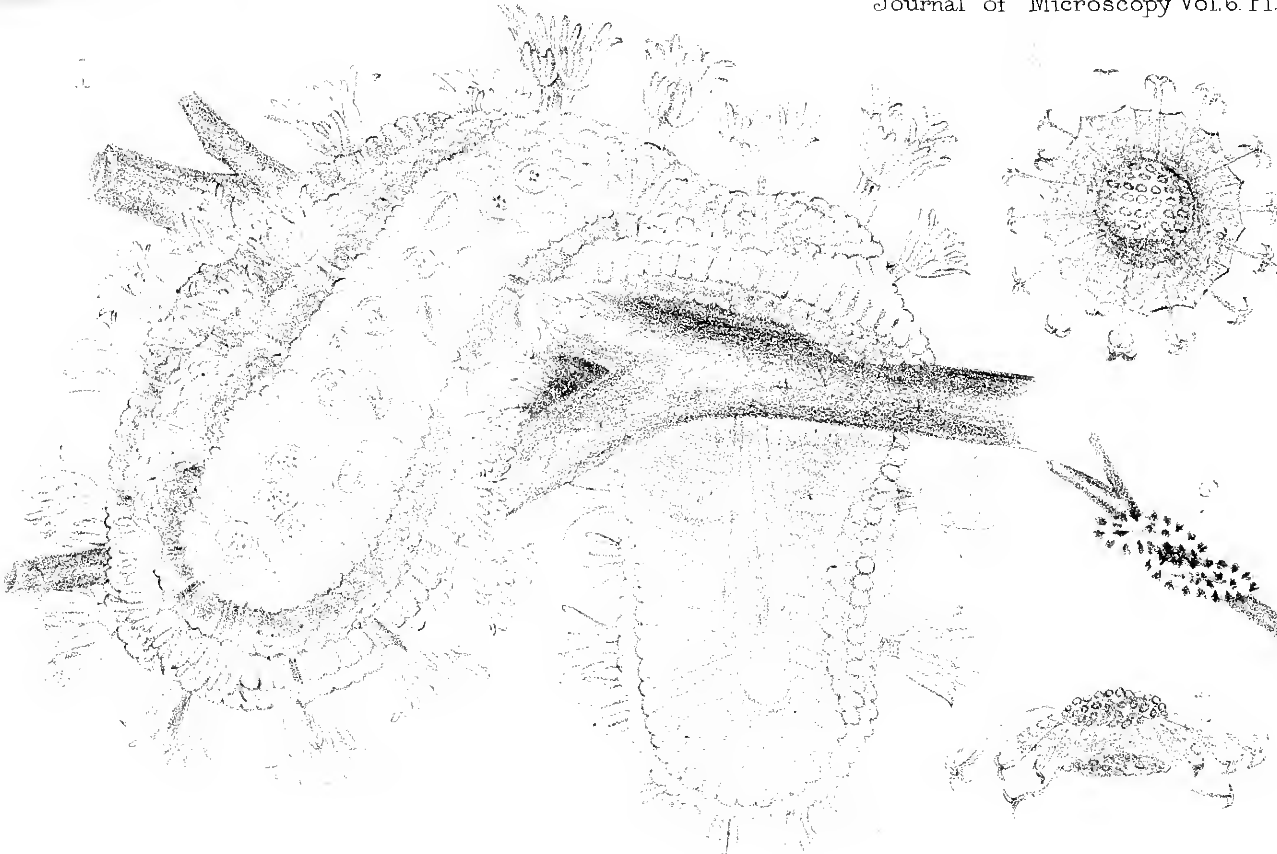
Plate IX.

Fig. 1.—Young Cristatella, just hatched.
,, 2.—Subsequent growth of same.

Plan of Polyzoon



Cristatella mucedo.



Colony of Cristatella mucedo &c

PLATE X.

Fig. 1.—A Colony of Cristatella, highly magnified.
,, 2.—The same, slightly magnified.
,, 3.— Statoblast, front view.
,, 4.—Ditto, side view.

Plates VIII. and X. are after drawings by Prof. Allman.
Plate IX. is drawn by R. H. Moore, from specimens in his aquarium.

On some Curious Facts connected with the Evolution of the Eye. *

BY MRS. BODINGTON.

SINCE DARWIN first clearly laid down the great laws which govern evolution, hundreds of zealous disciples have worked at the problem of which the great master had found the key. I am old enough to remember that most of the facts in zoology which were considered special stumbling blocks in accepting the theory of evolution, proved special triumphs from the attention which they drew. Amongst other objections, it was said, that if horses had been evolved, a five-toed form must have existed, and the five-toed form has been found ; that marsupials must have been specially created for the regions where they are found—viz., Australia and South America—yet behold, marsupials were found amongst the earliest known fossil mammals in Europe. In the same way, many things, which the prophetic eye of the great master saw would be found out as to evolution, were specially ridiculed. That mammary glands would be found to be modifications of sebaceous glands, and that eyes would be found to originate from modifications of epidermal cells, were among those prophetic utterances which all recent researches prove to have been true.

I only propose to take a very small portion of the great subject of evolution to-night—viz., a few curious facts relating to the evolution of the eye. They will, I hope, illustrate the importance of both the great branches into which zoology tends to divide—

* Paper read at a meeting of the County of Middlesex Natural History Society, December 21st, 1886.

namely, phylogeny (or the tribal descent of animals), revealed by embryology aided by palæontology, and the discovery of archaic surviving forms. The other great branch of the science—also of surpassing interest—deals with the modifications of organs by use and disuse.

I will first deal with the modifications of organs by use and disuse. These modifications are profound, and are, perhaps, more striking in animals of parasitical habits than in many others.

Semper gives the following description of *Sacculina* and other Cirripedes, degenerate crustaceans of parasitical habits:—

"As a rule, almost without exception, the larvæ of parasites move about freely in water. During this stage the larvæ are usually high in the scale of structure. Those of the parasitical *Cirripedia*—for instance, *Sacculina*—have, in what is known as their Nauplius form, external organs of locomotion of a complicated character, a muscular system of the Crustacean type, a well-developed intestinal canal, and usually have special organs of sense—*eyes*. Gradually, this Nauplius, after attaching itself to the tail of a crab, loses its organs of locomotion, the greater part of its muscular and nervous system, its organs of sense—including, of course, the eye—and often its mouth, stomach, and intestinal canal. The lively crab-like larva is transformed into a shapeless sac, exhibiting no trace by which its crab-like nature can be recognised.

Animals adopting a sedentary mode of life tend also to lose their sense organs, and especially their eyes. The free-swimming Nauplius, of the sessile Cirripedia, developes six pairs of strong swimming feet and a pair of composite eyes. When the Cirripede has settled down for life, "fixing itself on its head and kicking its food into its mouth," as Miss Buckley described it, it has no further use for its eyes. It is glued head downwards in its shell, and only the modified ends of the feet appear.

The Ascidian larva possesses a median eye. Some Ascidians, or their near relations, as we know, kept their larval tail, and, as further history will show, their median eye, and developed into the ancestors of vertebrate animals. Others preferred a life without vicissitudes and danger, quietly anchored themselves, gave up their eyes and tails, and became little else than shapeless

sacs. Which Ascidian was the wiser in his generation, I for one can hardly tell: whether a life in the sea, where one was fixed beyond the power of storms to move, and daily food came with every ocean current; or the fierce struggle for existence, and cruel sufferings of the weak, which higher reason brings.

An interesting history of tribal descent is shown in the eye of the Dibranchiate Molluscs, as compared with the eye of Nautilus. The eye of Nautilus is among the most interesting structures of that remarkable animal—a sole survivor of a long extinct species. No other animal so high in organisation has so simple an eye as that of Nautilus. When looked at from the surface, no metallic lustre, no transparent coverings, are seen. It is simply a slightly projecting hemispherical box like a kettle-drum, half an inch in diameter, and in the middle of the drum membrane is a minute hole. It was very naturally thought some membrane had covered this hole during life, and had been ruptured in the specimen studied by Owen. But further researches showed that this hole is a natural opening into the globe of the eye, which is accordingly filled with sea water during life. In short, of all the parts which in common parlance are called the eye, none exists in this most primitive optical apparatus, which is arranged to form an image on the principle of the "pin-hole" camera. There is no cornea and no lens, and the naked retina is bathed by sea water on one side, and on the other receives the fibres of the optic nerve.

The most interesting consideration connected with this eye of Nautilus is this—that the elaborate lens-bearing eyes of the Dibranchiate Molluscs, such as the well-known cuttle-fish, pass through an embryonic stage of development, in which they have exactly the structure of the eye of Nautilus—namely, of simple open sacs. Such, too, is the structure of the eye in the limpet.

I come now to one of the most recent and curious discoveries in the history of descent. As every zoologist knows, a special interest attaches to all transitional forms; the most apparently insignificant animal becomes invested with the highest value, where it can be said to form a link between the different branches of the animal kingdom. The Ascidian, the lancelet, the mud-fish of Australia, are all examples in point.

A learned professor is even now in New Zealand investigating

the habits of a most insignificant looking worm-like animal, *Peripatus*, and in the Cambridge lecture rooms, this creature is the observed of all observers. Why? Because in *Peripatus* is found a link between worms and arthropods. *Hatteria*, a lizard of very ancient type, has long possessed a similar interest, now intensified through the recent discovery which shows the unquestionably invertebrate descent of this vertebrate animal. I will quote an extract on the subject from the *Contemporary Review* for October, premising that fully equal honour is due to the German, as to the English discoverer. The Englishman was simply bolder in publishing his discovery.

"One genus alone is extant of the lizard-like reptiles known as *Rhynchocephalia* (from their beak-like, horny mouths). This genus comprises only the *Hatteria* of New Zealand. Mr. Spencer, of Oxford, whilst engaged in studying the anatomy and histology of this animal, found a curious sense organ buried in the substance occupying the parietal foramen [the suture at the top, across the middle of the skull]. This sense organ was placed on what is known as the pineal body, the function of which has been hitherto unknown. This pineal body arises from the roof of the third ventricle [or *fore brain* of embryologists], and in both Amphibia and Reptilia becomes divided into two parts, one retaining connection with the brain, and the other, a bladder-shaped structure, which is usually completely separated from the former. In *Angus fragilis* [a degenerate lizard commonly known as the blind worm] this bladder-shaped structure resembles a highly-organised invertebrate eye, *but without any nerve.* In *Hatteria* this portion also becomes an eye, but an eye provided with a *well-marked nerve.* This eye is simple, lying exactly in the middle line, under the parietal foramen, an aperture at the anterior end of the median suture of the parietal bones. A depression of the skin of the head occurs immediately over this parietal foramen, but does not lead down into this, which is filled up with a plug of connective tissue, which is specially dense round the capsule that envelopes the eye. The capsule is also filled up behind with connective tissue, in which a blood vessel, entering with the nerve, divides and ramifies. The nerve is single. It is palpably a well-constructed invertebrate eye—the eye of an

invertebrate animal buried in the skull of a vertebrate animal. As it lies in its capsule, looking upwards, the lens is first seen; it forms the front boundary of a vesicle, the walls of which, starting from within outwards, are made up of a layer of rods, embedded in dark brown pigment, which is specially developed in front; and a double or triple row of nuclei, succeeded by a clear layer, and followed by an outer layer of nuclei, composed of two or three rows. These are practically the elements of the invertebrate eye, and in their normal order. The relation of these parts in the eye of the vertebrate animal is the exact opposite of this; the rods and cones being furthest from the cornea and from the light. This is explicable by their different mode of origin embryologically, but it establishes a complete difference between them. In this lizard we have at the top of the pineal body a distinct molluscoid or invertebrate eye."

Now, as the pineal body is found in all the higher vertebrates including man, we have a convincing proof of the descent of the higher vertebrates from a form as low as that of the existing Ascidian larva, as foretold by Darwin. The pineal body in all its stages shows an interesting case of loss of function from disuse. More highly organised eyes have been formed in the higher animals, and the median eye has therefore become useless. We need not go beyond our own county of Middlesex to find animals with eyes becoming atrophied through disuse. It was long a question with naturalists whether the common mole is or is not blind. I have not got Frank Buckland's book by me, but I think it was he who says, with an airy contempt for strict scientific investigation, that the mole is not blind, because if you part its fur you can see its eyes. Let me quote Semper again, and find out the real state of the case.

He (Semper) says:—"This animal, whose peculiar habits are known to everyone, has true eyes, from which none of the essential parts of the eyes of Vertebrata are absent, although these parts are all of the simplest, almost of embryonic structure. The whole eye is very small, deeply imbedded in muscles, and quite covered by the skin, so that it is quite invisible, externally. The lens consists of a very small number of minute and little altered embryonic cells; the retina, in the same way, is much simpler

than in the eyes of other Vertebrata. Degeneration, then, such as makes the eye incapable of seeing, has not taken place; nevertheless, the eye of the mole is reduced to total inefficiency. The blindness of the mole is the result of *complete degeneration of the optic nerve*, so that if images could be formed in the eye itself, they could never be transmitted to the animal's consciousness. *In the embryo of the mole* and *without exception*, both eyes are originally connected with the brain by well-developed optic nerves. This may indeed be regarded as a conclusive proof that the blind mole is descended from progenitors that could see, and that the total blindness of the animal has been caused by the directly injurious effects of darkness on the optic nerve."

Another case of blindness arising from living in darkness, is that of a parasitic crab, *Pinnotheres*, which, in its adult state, lives in the "water lungs" of Holothurians. The animal has well-developed eyes in its free-swimming zoœa stage, and even when it enters its Holothurian host, preserves these eyes, but as they grow, they gradually become blind; the brow grows forward over the eyes, and finally covers them so completely, that in the oldest individuals not the slightest trace of them is to be seen through the thick skin; while at the same time, the eyes seem to undergo a more or less extensive retrogressive metamorphosis.

There are numberless other instances of blindness in animals from disuse, which I have no time to mention. I will only allude to the curious fact that whilst some fishes living at great depths are totally blind, others have immensely developed eyes. Also in all the species of the cave beetle, *Thachærites*, the females only are blind, while the males have well-developed eyes, yet both sexes live together in absolute darkness.

These cases appear to present difficulties, yet they seem to me not very difficult to account for. Unless the beetles were specially created in the total darkness of the caves and the fishes specially created for the abysses of the ocean, they must each have had a tendency to greater development of the eyes, as they receded from the light. The female beetle would find her food at the bottom of the cave, and would soon lose the use of her eyes, but the males woulduse their eyes so long as there was any light at all to guide them, and the retrograde development in their case would probably

only begin countless generations after that in the eyes of the female.

In the case of deep sea fishes Dr. Günther says: "The organ of sight is the first to be affected by a sojourn in deep water. Even in fishes which habitually live at a depth of only 80 fathoms, we find the eye of a proportionately larger size than in their representives at the surface. In such fishes the *eyes increase in size with the depth inhabited by them down to the depth of* 200 *fathoms.*"

Dr. Günther had previously said that the rays of the sun probably do not penetrate to, and certainly do not extend beyond the depths of 200 fathoms.

He continues: "Beyond that depth small as well as large-eyed fishes occur, the former having their want of vision compensated by tentacular organs of touch; the latter, the large-eyed fish, can only see by the aid of phosphorescence. In *the greatest depths blind fishes occur*, with rudimentary eyes, and without special organs of touch. Many fishes of the deep sea are provided with more or less numerous round, shining, mother-of-pearl coloured bodies imbedded in the skin. These, when large, are placed on the head, in the vicinity of the eye; the smaller ones are arranged in series along the side of the body and tail. The former kind of organs possess, in the interior, a body like *the lens of an eye*, and are considered by some naturalists to be true organs of vision, developed to catch the phosphorescent rays emitted by numerous deep sea organisms." The functions of the globular bodies arranged along the sides of the fish are at present unknown, but Dr. Günther thinks there is no doubt that the functions of these organs have relation to the peculiar conditions of light—wholly phosphorescent—under which these fishes live.

I now come to a case of extraordinary development of the visual organs. Upon many of the coasts of the Pacific Ocean, is found a mollusc of the genus *Onchidium*. This mollusc has eyes of the ordinary invertebrate type placed upon its head. But the greater number of species of this genus have other eyes situated on the shell-less but rough back of the animal. These eyes, simple as they are in structure, are extremely interesting, for they are identical in type with those of the vertebrate. It is the only

example hitherto known of an eye so constructed in an invertebrate animal. "During many years of travel," says Semper, "these eyes were totally unknown to me, but I had devoted much attention to the mode of life of the *Onchidia*. They live exclusively on the seashore or in brackish marshes; they creep along close to the edge of the water, hiding in clefts of the rocks or under large stones. Together with them in small spots live the genera of fishes, *Periophthalmus* and the nearly allied *Boleophthalmus;* these skip along the strand with long leaps, seeking their food, which consists principally of this very genus of *Mollusca*. This, it seems to me (continues Semper), seems a way of accounting for the development of these dorsal eyes.

"The *Onchidia* are terribly slow creatures, perfectly incapable of escaping or of withdrawing rapidly into a crevice for shelter. They eat nothing but sand, of which, of course, they digest nothing but the nutritious organic particles mixed with the sea-sand. Thus, in order to seek their food, they must often be exposed to the gaze of the swift fish that leap rapidly along the edge of the sea. Fly they cannot; a house into which to creep, as many molluscs have, they have not; they have neither spines nor jaws with which to defend themselves, and the eyes on their back can do no more than warn them of the approach of danger. It would be very strange if such eyes were developed in that particular position, unless some weapons were provided, too, for rendering the eyes of service. Such weapons do exist, in point of fact, in every species that has dorsal eyes. The skin of the back is thickly set with minute glands, closely surrounded by circular muscles. Feeble contractions of the skin cannot force out the minute globules which are secreted by the glands. But, supposing a *Periophthalmus* approaches suddenly and with rapid leaps, it rises —as I have often seen—several inches into the air. The mollusc has all its eyes—and I have positively counted *ninety-eight* on one specimen—turned upwards in various directions. Suddenly becoming aware of the fish or its shadow, it instantly draws up its whole body, thus contracting the glands on the skin with its whole force. The minute globules of secretion will be thrown into the air, in hundreds and thousands, towards the pursuing fish. The fish, hit by the shower of minute shot, retires from the pursuit, and *Onchidium* is safe."

Semper gives this only as an hypothesis, because the globules, being microscopically small, could not be *seen* by him to fly in showers. But what is certain is that *Onchidium* has these dorsal eyes of vertebrate type on all coasts where its dreaded enemy is found ; but on the Atlantic shores of England and France, or the high northern coast of America, or the west coast of N. and S. America, and the Galapagos Islands, there is no *Periophthalmus*, and *Onchidium* has neither dorsal eyes nor dorsal glands. Whether it is worth while to develop ninety-eight eyes on one's back in order to be ready to shoot perpetually at a terrible enemy is an open question. It would seem more peaceful and easy to be swallowed up at once than to live in such a perpetual state of apprehension.

I think all the instances I have given will show in what an extraordinarily interesting way the environment of an animal will act upon its visual organs. Gradually, in the course of ages, the highest animals of all the higher divisions of the animal kingdom have found the head the most useful position for eyes for all purposes. But Nature was quite prepared to develop eyes upon any part of the body, and has by no means forgotten how to do so still. The star-fish has an eye-spot at the end of each arm, as though a dog had an eye at the end of each paw. In the *Chitonidæ* (Gastropod Molluscs) Thoresby has detected more than 10,000 eyes on the exposed surfaces of their shells. The scallop has eyes placed all along its mantle. An annelid, *Polyophthalmus*, has a pair of eyes on every segment of its body, and some worms have eyes on the *last* segment of their bodies. Some have eyes on their tentacles, and others on their gills.

People are sometimes fond of constructing romances, where in imagination they visit other planets. The people in these planets always turn out to be distressingly like ourselves. It appears to me that if planets were described as inhabited by invertebrate animals grown big and intelligent, we should have very novel and amusing conditions of society to describe. A planet inhabited permanently by a set of old maids, where gentlemen were grudged even a few days of life, and one matron presided over the whole community, where also there were no paupers and no starvation, and children were brought up as in the Republic of Plato, would

be very new. And so would a world be, where everyone had their mouths in the middle of their bodies (rivalling the *Anthropophagi*), and their eyes at the ends of their fingers and toes. The conditions under which one would go to a dinner-party or look on at a play would be very different to anything to which we are accustomed. But I must leave the development of this idea to some inventive genius, and bring this too long paper to an end.

Authorities Consulted.

Darwin—Origin of Species.

Semper—Animal Life.

Encyclopædia Britannica—Articles: Ichthyology—A. Günther; Mollusca—E. Ray Lankester.

Bell—Comparative Anatomy and Physiology.

Nicholson—Manual of Zoology and Manual of Palæontology.

Haeckel—Evolution of Man.

Contemporary Review, October, 1886:—

A. Buckley—Life and Her Children;

Huxley—Anatomy of Invertebrates.

The External Anatomy of the Dor-Beetle.

By Robert Gillo.

Plates XI., XII., XIII.

IT is well known that beetles have a hard exterior covering or case of chitine, inside of which are securely lodged all the internal organs. When speaking of the limbs, it may be said that beetles have their muscles inside their bones, for the chitinous covering serves not only for an exterior skin, but it also forms a system of very strong and rigid levers, similar in their adaptation to the bones of the higher animals. There is, moreover, a distinct advantage gained by this arrangement, for it is a fact in mechanical construction, that where rigidity and strength are required, they are best attained by disposing the material in a tubular form. Hence the limbs of beetles are much stronger than they would be if they were made solid and contained only the same amount of strengthening material. Their bodies are not,

however, entirely covered with this armour. A portion of the abdomen under the wing-cases or elytra, for instance, where the flexibility of the covering allows of the expansion and contraction necessary for the act of breathing, is constructed of a much softer material. Nevertheless, these softer parts are enclosed in a tolerably firm skin to protect them from injury. Beetles, like the warriors of old, are enclosed in plate armour, that of the beetle being much more skilfully designed and constructed ; and although these insects display an immense variety of form and structure, a certain unity of plan runs through them all.

To get anything like an idea of the forms of these interesting insects, it will be best to take a few leading types, choosing, as far as possible, the larger species ; and on the present occasion I propose to take the Dor-Beetle as an example of a dung-feeding, fossorial beetle.

Before commencing to describe the various parts of this insect, it may be well to say a few words as to its name, classification, etc. The beetle must be familiar to every one, being so frequently seen flying about in the dusk of evening, more particularly during the autumn season. In its heavy, lumbering flight, it is not unusual for it to strike individuals in the face. Hence, it has received the name of Dor, or Darer. It is undoubtedly the beetle Shakespeare alludes to when he says, "The shard-borne beetle, with its drowsy hums." I will not in the present paper go into the question as to whether it was *shard-born* or *shard-borne* which Shakespeare wrote, but it may be stated that if it was shard-borne—meaning that the beetle in its flight is borne on its shards, or elytra—he was wrong from a naturalist's point of view, as during flight the elytra are merely held up out of the way so as not to interfere with the action of the large membranous wings.

The form of the antennæ at once shows that it belongs to the great family, Lamellicornia—*Lamella*, a little plate, and *cornu*, a horn. In this case the club of the antenna consists of three leaves or plates, the middle one of which is partially enclosed by the other two, all three being densely pubescent. It belongs to the genus *Geotrupes*, signifying *earth-borers*. The suitability of this term will be at once seen when the habits of the beetle are stated.

Having found some fresh dung of almost any animal—and it evidently does this by the sense of smell, which faculty it must possess in great perfection—the beetle sets to work and digs a hole under it into the ground, perpendicularly, to the depth of eight or nine inches, and at the bottom of it places a ball of the same, as food for the future larva. There are several species of Dor-Beetles, some of which are not so common as others, but the one chosen is that which abounds, I believe, everywhere, and most certainly in Somersetshire. It is *Geotrupes spiniger* (Marsham), synonymous with *G. mesoleius* (Thoms). It probably received the name *spiniger*—or prickly—from the fact of the male possessing a large tooth bent downwards on the under sides of each of the anterior tibiæ (Pl. XI., Figs. 8 and 9); a large hooked tooth on each of the posterior femora; and a hooked process at the tip of each of the posterior trochanters (Figs. 6 and 7). All these are evidently sexual developments, giving the male a better power of grasping. It varies very much in size, as in fact do all those beetles which in the larval state feed on a supply of food placed for them by the parent, or in any way have to get a precarious living; whereas plant-feeders and those that subsist on substances of which there is an abundance, are very constant in size. Specimens of the Dor-Beetle may be met with nearly one inch in length, and small ones, scarcely more than half this length, may occasionally be found.

I now propose to notice the principal external parts of this beetle, commencing with the head and mouth organs. The head is very hard and strong, and the clypeus has a ridge down the centre, so that both vertically and laterally it is of a wedge-like form. The situation of the eyes is peculiar, for a very hard band of chitine is continued from the sides of the clypeus, so as to encircle and divide each eye in such a way that a portion of the eye appears on the upper side of the head and a larger portion on the lower side (Pl. XI., Figs. 1 and 2, *b* and *c*). Without this protection it is evident that as the beetle worked its way into the ground head downwards, the eyes would be damaged. The short antennæ consist each of eleven joints, which in the Coleoptera is the normal number. The first joint is by far the longest, and the last three form a trilamellate club, as previously described. When the

beetle is digging, the antennæ lie down on the under-side of the head (Fig. 2, *a*), thus forming an additional protection to the eyes, whilst the clubs of the antennæ are securely lodged in cavities on the under-side of the *pro-thorax*, or, more properly speaking, the *pro-sternum*.

The mouth-organs, as may be expected, are not very powerful, seeing that the beetle feeds on material which has already gone through a very perfect process of trituration. The mandibles do not exhibit that peculiarity of form which may be seen in the species of *Geodephaga* and others, the right and left mandible being precisely alike. The various species of this genus have their mandibles formed rather differently externally. For instance, *G. stercorarius* (Lin.) has a hollow near the top, and then the outline continued in one uniform curve, whereas, in the one under our notice, there are two hollows followed by a tolerably straight portion. The tips of the mandibles are of a chisel form, and act in the same way as the incisor teeth of the Rodents. The whole of the inside edge on the under side is set with hairs and bristles, and from about half way down to the root the mandible is of a peculiar structure (Figs. 4—5); it appears to be membranous, with about thirty longitudinal ridges, each of which is again ridged or striated transversely. The use of this is, no doubt, to assist in sweeping the food into the centre part of the mouth, and prevent its escaping, which must be very necessary, as the beetle feeds on such a soft semi-fluid pabulum. The labrum (Fig. 3) is of a somewhat rectangular form with the corners rounded, but the most remarkable part about it, is the way the under side is set with hair and stiff bristles recurved inwards, evidently also to assist in retaining the food in the mouth. Referring to the under side of the head, the mentum is very elongate, and deeply emarginate in front. The labium is very short and fleshy, and its palpi with the usual number of four joints is moderately short. The maxillæ are only peculiar inasmuch as the laciniæ, or blades, are not very large, and are clothed with hair, and have not the well-developed hooks to their tips, which is so strikingly shown in the *Geodephaga*, their palpi are very short, and the inner lobes are in the form of a wide, flat brush.

The thorax consists of three portions: the prothorax, meso-

thorax, and metathorax; the upper side being respectively called the pronotum, mesonotum, and metanotum, and the underside, the prosternum, mesosternum, and metasternum. The pronotum is the portion which in general language is called the thorax, and in this species is large, rounded, and smooth, with a few punctures near its sides; its underside, the prosternum, which really consists of three parts—the sternum, episterna, and the epimera—carries the anterior pair of legs, which in this beetle are remarkably powerful. In proof of the strength possessed by this beetle, I quote the following:—

"Having repeatedly placed one of these Dor-beetles, weighing 15 grains, under a weight equal to 4,796 grains, sufficient, it would be considered, to crush its body, being 319 times its own weight! it heaved it up and withdrew, and the same pressure being placed on its leg, it was immediately disengaged by the powers of the other. A man to have accomplished a proportionate feat, must have raised his body from an incumbent pressure of about 20 tons."—*Knapp's Journal of a Naturalist.* From *Science Gossip*, 1865, page 41.

The legs, as in all insects, consist each of three important parts: the femur or thigh, the tibia or shank, and the tarsus, which corresponds to the hand or foot of man. The *tarsi* of this beetle are small and weak, consisting of five joints, which is the normal number; the last joint being terminated by two moderately long, curved, but very sharp claws. The tibiæ of the anterior legs are very strong and wide, their outside edges having large teeth, particularly towards their tips. These enable the beetle to loosen the earth in front of it, so that with its other legs it is able to push the material behind, and so work its way into the ground. They are, in fact, its digging implements, acting much in the same way as a gardener's fork, and everybody knows how much easier it is to dig with a fork than it is with a spade. When the Beetle is digging, the tarsi are folded back, and lie upon the tibia, and in this way are preserved from injury; the same plan may be noticed carried out in all fossorial beetles.

The femora are very large, as may be supposed, so as to contain the very strong muscles necessary to move the legs with the great power which the beetle has been shown to possess. It

must be noticed, that the joints of the legs are on the hinge-like principle, so that they can move in one plane only; and here it may be pointed out that in man the action of revolving the hand, or, as it is called, pronation and supination, is effected by the ulna and the radius moving round each other in the forearm, but no such arrangement is possible in the case of beetles, and would be a very weak one if it were; nevertheless, a motion of this kind is necessary, and it is effected in a very perfect manner by the femur being attached to a moveable portion called the coxa, which lies in a hollow in the sternum, and is held there by very strong ligaments; it rolls round in a plane at right angles to that of the joints of the legs, so that it is, in effect, like a ball-and-socket joint, and at the same time is possessed of great strength. As the femora are driven forcibly against the coxæ when the beetle is exerting its strength in digging, and as sharp particles of sand and dirt would get between the parts, thus causing great friction, the under sides of the femora have a space covered with hairs, which act as cushions, and also as brushes, for sweeping the gritty particles away. There is also an additional portion which appears to be a protection to the joint between the femur and coxa, somewhat on the same principle as that of the patella or knee-cap in man. These portions are the trochanters, as may be seen more developed in the intermediate and posterior legs than in the anterior pair. It has been previously pointed out the posterior trochanters are elongated and hooked at their tips for a sexual purpose. The tibiæ of the posterior legs are more square in form than those of the anterior, and on the outside have three prominent ridges. These are useful to the beetle to push the earth behind it when it is digging, also to give it a hold so as to be able to force itself forward. The intermediate legs are very similar to the posterior, but less developed. In some of the other species of this genus, as *G. sylvaticus* (Panzer), and *G. vernalis* (Linnæus), the posterior tibiæ have only two tranverse ridges.

The mesothorax carries on its under side, properly called the mesosternum, the intermediate legs, and on its upper side, or the mesonotum, the elytra or wing cases, and when the wings are not extended for flight, the mesonotum is concealed by the elytra with the exception of the scutellum, or little shield, which appears as a

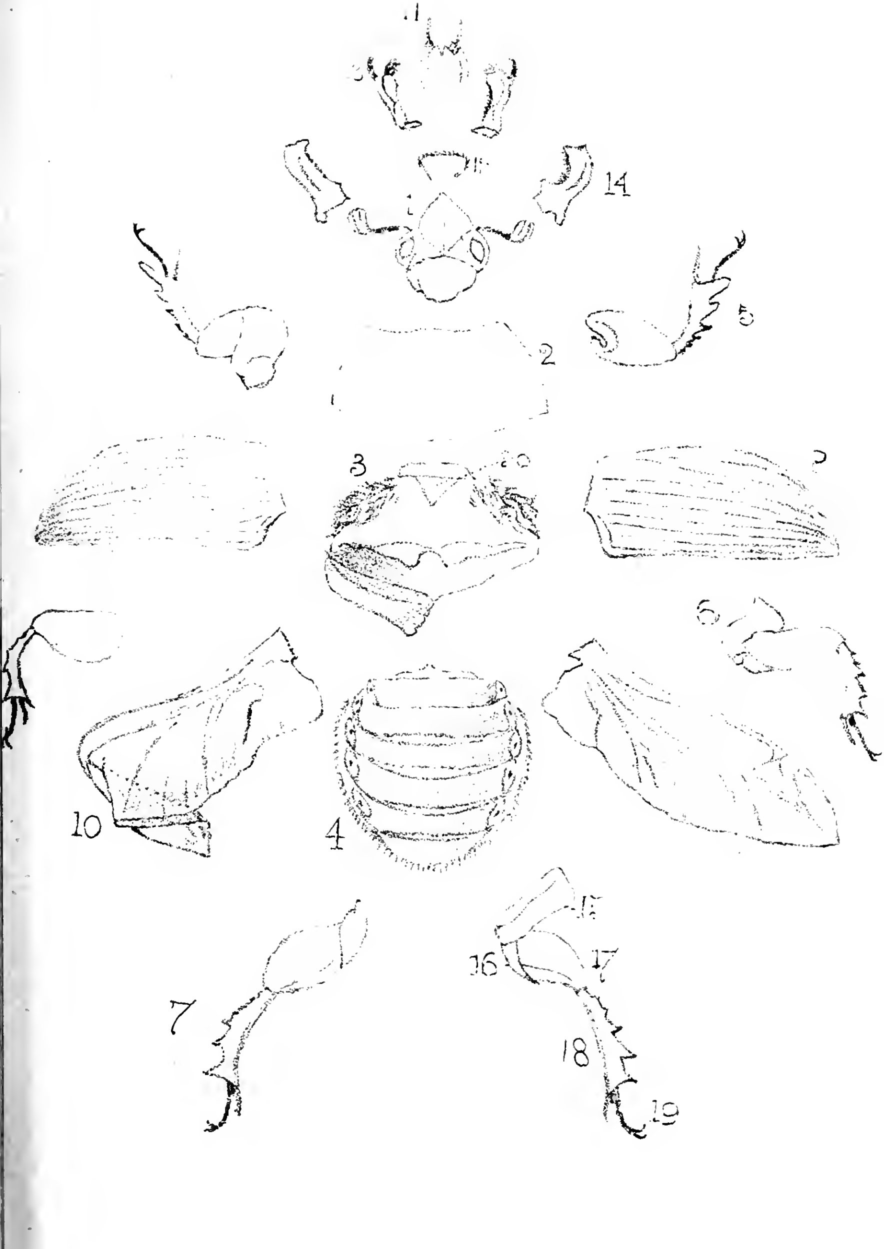
small triangular portion between the elytra at their bases. The elytra are hard and sufficiently large to completely cover the entire upper surface of the abdomen; they are somewhat irregularly and indistinctly striated longitudinally, there being seven striæ between the suture and the humeral prominence. It may be noted, that this projection at the shoulders is a very common feature in all those beetles that have large membranous wings; it appears to be a necessary consequence of the room taken up under the elytra, by the wings near their attachment to the metathorax when folded.*

The metathorax—which is so far united to the mesothorax, that the line of separation can scarcely be distinguished—carries on its under side, or metasternum, the posterior pair of legs, and on its upper side, or metanotum, the pair of membranous wings. These are the organs of flight, and when extended are large and ample, and as they are obviously too large to lie under the elytra extended, they are constructed for folding, which is attained by the great costal nervure having a hinge-like joint about one-third of its length from the tip, so that the tip portion shuts up until it takes up a position at about right angles to the rest of the costa, and the membranous portion naturally falls into folds; in this way they lie compactly under the elytra concealed and protected.

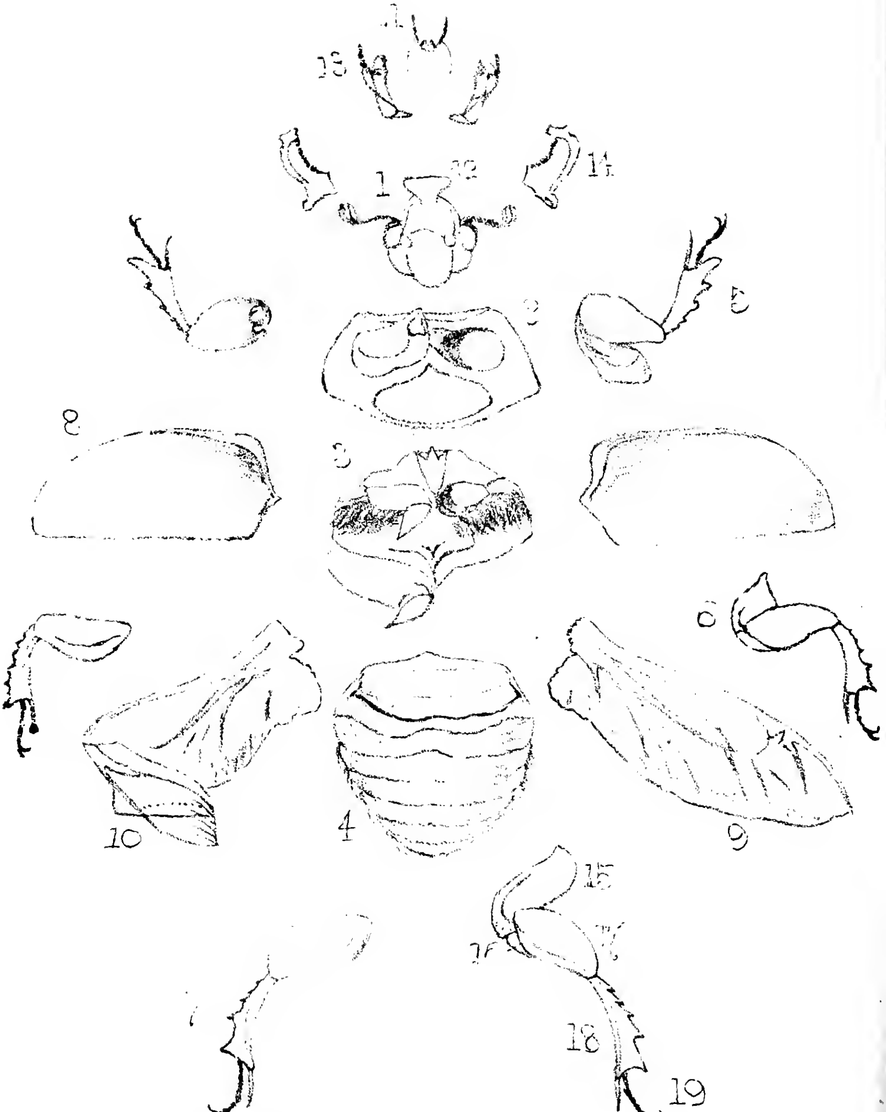
The only portion now remaining to be described is the abdomen, consisting of nine rings, which fit one into the other like a telescope; they are soft on the upper side, where they are protected by the wings and elytra, but are chitinous on the under side. The terminal rings, however, on the upper side, are harder than the rest, being more or less exposed, particularly the last one, which in some beetles is very important, and is called the pygidium. The rings are best seen on the upper side, as, owing to the great space taken up by the meso- and meta- sternum for the attachment of the coxæ, the first rings are much contracted on the under side. They are joined together by an elastic membrane, particularly at the lateral margins, on the upper side, where there is a soft portion, in which are situated the abdominal spiracles.

* Another species, *G. mutator* (Marsham), has nine striæ between the suture and this prominence.

Anatomy of Do. Beetle



Anatomy of Dor Beetle



Anatomy of Dor Beetle

In this short description of the Dor-beetle, I have not attempted in any way to exhaust the subject, or even to note all the various parts of its external anatomy, but merely to give a general idea of the plan on which it is constructed, and to direct attention to a few of its more peculiar features.

EXPLANATION OF PLATES XI., XII., XIII.

Plate XI.

Fig. 1.—Upper side of half the head:—*a.*, antenna; *b.*, band of chitine protecting the eye; *c.*, clypeus; *e.*, the eye; *lbr.*, labrum; *m.*, mandible.

,, 2.—Under-side:—*a.*, antenna resting in cavity of prosternum; *b.*, band of chitine protecting the eye; *e.*, the eye; *m.*, mentum; *lb.*, labium; *p.*, labial palpus; *mx.*, maxilla; *mx.p.*, maxillary palpus.

,, 3.—Half the under-side of the labrum.

,, 4.—Mandible, under-side.

,, 5.—An enlarged portion at *b.*, which consists of about 30 ridges of chitine, striated transversely.

,, 6.—Posterior femur of female.

,, 7.—Ditto of male.

,, 8.—Anterior tibia and tarsus of male.

,, 9.— Ditto female.

Plate XII.

The Dor-Beetle, *Geotrupes spiniger*—female—upper-side, dissected.

Plate XIII.

The same under-side, dissected.

The following numbers refer to the same organs in both plates:—

1.—Head.
2.—Prothorax.
3.—Meso- and Meta thorax.
4.—Abdomen.
5.—Anterior leg.
6.—Intermediate leg.
7.—Posterior leg.
8.—Elytron.
9.—Membranous Wing, extended.
10.—Ditto ditto, folded.
11.—Labium.
12.—Labrum.
13.—Maxilla.
14.—Mandible.
15.—Coxa.
16.—Trochanter.
17.—Femur.
18.—Tibia.
19.—Tarsus.
20.—Scutellum.

Notes on Flora met with on the occasion of the Excursion of the Society to Hampstead, with Special Reference to that of Caen Wood.*

By Dr. H. J. Wharton, M.A.

AFTER a pleasant walk from Hampstead across the Heath, during which Mr. Clement Reid, of the Geological Survey, gave some interesting sketches of the geology of the locality, the excursion was, through the courtesy of Lord Mansfield, pleasantly and unexpectedly diversified by an interesting *detour* into Caen Wood, although the autumn day was too short for us to do anything like justice to the locality. Caen Wood is better known by name than it is in reality, but the spot has no equal, from the naturalist's point of view, within a similarly short distance of London.

We are now taught, by those who should know best, that we ought to call Caen Wood "Ken Wood," and that Kentish Town is no other than Ken-ditch Town. Certain it is that the well-known series of Highgate Ponds have their source in Caen Wood, and that they empty themselves into the Thames by way of Kentish Town; only the brook, whose name still survives in that of Fleet Street, has long since been converted into a main sewer.

The lake in Lord Mansfield's park had a great interest to those who had brought collecting-bottles with them; and some examples of *Nitella*, one of the *Characeæ*, were readily found close to a little forest of bulrushes (*Typha latifolia*). I have no doubt that many lowly fresh-water *Algæ* were obtained at the same time, of which we may hear more hereafter. But I was anxious to push on, and ascertain whether any plants of the rare May-lily (*Maianthemum bifolium*) were still to be discovered. My search, however, was vain, for I could not find the spot where it grows.

This flower is the great speciality of Caen Wood. I may mention that it rarely produces fruit there, although in that

* This paper was also read at the meeting of the "Middlesex Natural History Society," in Dec., 1886.

year it was easy to find a sufficiency of berries. The plant at present grows only on one spot, but it covers almost the whole of the area of about twenty square yards, on an eminence under the shade of a very large beech-tree, near the south-east angle of the grounds. It is known to have existed there for nearly a century, and it has certainly come to have all the appearance of being a native. It is a species which is generally dispersed over Europe, Russian Asia, and North America. But its only recognised habitat as a truly indigenous British plant is on the west side of Forge Valley, near Hackness, in Yorkshire, six miles from Scarborough, where it occurs in abundance. It has also been reported from Lancashire and Bedfordshire, but on insufficient evidence.

As the name of the plant is rather a puzzle, I should mention that it is also often called *Smilacina bifolia*; and that it appears as *Maianthemum Convallaria* in the last edition of the standard "London Catalogue of British Plants." It has no true English name; that of May-Lily is more often applied to the Lily-of-the-Valley. *Maianthemum* means "May-flower."

The only other botanical feature of our afternoon's walk which seems worth recording is the luxuriant growth of the Blue-leaved Spleenwort (*Asplenium Ruta-muraria*) on the kitchen-garden wall of Caen Wood. This wall extends for a furlong or so along the road-side, and along the upper rows of bricks this little fern seems to have found a more congenial house than it has anywhere else so near London. It is worth a walk of many miles to see its almost unparallelled fertility there.

As the result of our excursion, Mr. Charles Emery, of Crouch End, an enthusiastic botanist, has sent me the following list of plants, representing eleven natural orders, collected on that occasion:—

Upright and Creeping Buttercup (*Ranunculus acris* and *R. repens*).
Shepherd's Purse (*Capsella bursa-pastoris*).
Greater Stitchwort (*Stellaria Holostea*).
Dwarf Mallow (*Malva rotundifolia*).
Furze (*Ulex Europæa*).
Dutch Clover (*Trifolium repens*).
Bramble (*Rubus fruticosus*).

Tormentil (*Potentilla Tormentilla*).
Devil's-bit Scabious (*Scabiosa Succisa*).
Dandelion (*Taraxacum officinale*).
Rough and Autumnal Hawkbit (*Leontodon hispidus* and *L. autumnalis*).
Umbellate Hawkweed (*Hieracium umbellatum*).
Golden Rod (*Solidago Virgaurea*).
Long-rooted Cat's-ear (*Hypochæris radicata*).
Milfoil or Yarrow (*Achillea Millefolium*).
Black Knapweed (*Centaurea nigra*).
Common Ragwort (*Senecio Jacobæa*).
Harebell (*Campanula rotundifolia*).
Common Ling (*Calluna vulgaris*).
Fine-leaved and Cross-leaved Heath (*Erica cinerea* and *E. Tetralix*).
Common Hemp-Nettle (*Galeopsis Tetrahit*).
Wood Germander (*Teucrium Scorodonia*).
Wood Betony (*Stachys Betonica*).

On the Homologies of Certain Parts of Insects.

By A. Hammond.

I REGARD the microscope but as a means to an end, and if its use (as has been the case) has led me to form opinions on subjects extending beyond its range, I hope that the same extension of grasp may be found amongst those whose first love has commenced in a manner so similar to my own, and that they, too, commencing with the infinitely little, may find an interest in a subject which I cannot but feel, if my speculations are worth anything at all, embraces the structural relations of every member of the insect world.

The discussion of theoretical questions by one whose opportunities of acquiring general information have been so limited, or perhaps so little used, as my own may savour somewhat of presumption, and I know not certainly how far the same ideas may have occurred to others before me, and may consequently have

already been fully discussed. As I have not, however, seen them before enunciated in the form they have presented themselves to me, I will, with the kind permission of my friends, risk their advancement in these pages. The repetition of similar parts in successive rings or segments, distinctive of the *Articulata*, has always appeared to me to form one of the most interesting points of inquiry in connection with the study of insects.

How far is it possible to trace this repetition? The recognition of the fact by Savigny and others that the organs of manducation are the proper articulated members of distinct segments, the homologues of the organs of locomotion on the succeeding ones, suggest at least the possibility that other relations of a like nature may be observed. Mr. B. T. Lowne, in his "Anatomy of the Blow-Fly," p. 3, says:—"Each segment in the lowest articulata is normally furnished with two pairs of lateral appendages or rudimentary limbs, one pair placed above the other, the superior being dorsal and the inferior ventral; at least, such is their arrangement in annelides. Both pairs are much modified in the higher forms, and are often entirely suppressed. The segments themselves may be said to consist typically of four plates: a ventral, a dorsal, and a lateral plate on each slide; the superior appendages being placed between the lateral and dorsal, and the inferior between the lateral and ventral plates. In insects the wings, when they exist, represent the dorsal appendages, being placed between the superior and lateral plates." From this we may gather that the wings of insects are the superior pair of the two with which each segment is normally furnished. Now, I have not as yet met with any suggestion that the organs which are thus admitted to be normal parts of the skeleton may be traced in other than the wing-bearing segments, and yet what are the alternatives? Either that the wings are not normal parts of the structure, but something superadded; or that, being so, they are entirely suppressed in all the other segments. Either hypothesis appears more or less satisfactory, and the following considerations, derived originally from the study of the common cockroach, appear to me to offer at least a partial solution of the difficulty. But in order to show how the relations of the dorsal plates must necessarily be viewed when uncomplicated by the presence of wings, and at the same time to

suggest what appears to be a parallelism of type in this respect between the *Crustacea* and the *Insecta*. I have mounted a specimen of the common wood-louse, together with the cockroach, on one slide, and have given drawings of the same. See lower portion of Plate V., given in the January part of this Journal.

In the wood-louse will be observed a succession of dorsal plates projecting laterally beyond the body of the creature, the projecting portions being darkly shaded in the drawing. So also in the larval cockroach, by its side. The three thoracic segments are each covered by a continuous dorsal plate, in which as yet no indication of separation of parts is seen. These likewise project laterally beyond the body, the projecting portions being likewise darkly shaded.

Now, in the wood-louse, it is perfectly manifest that the whole breadth of each segment is the homologue of the whole breadth of every other. It would be absurd to regard the whole breadth of one as homologous with, say, the central grey portion only of the succeeding, and yet this very thing(*) appears to be done in the case of insects generally, and that of the cockroach in particular. In Figs. 3 and 4 on the plate will be found drawings of the dorsal surfaces of the thoracic segments of this insect in more advanced stages. In the first the dorsal surfaces are still continuous, but the markings now visible upon them distinctly foreshadow the approaching separation of the wings. In the male this separation is complete, but in the female the tegmina alone are completely separated, the wings proper being still only indicated by the markings referred to. The fourth figure shows the dorsal surfaces of the female thoracic segments in this condition. Now, I have always been taught to regard the great shield-like plates of the pro-thorax of this and other orthopterous and coleopterous insects as constituting in its entirety the dorsal plate proper of the segment, while at the same time I have been equally led to regard the dorsal plate of the next or meso-thoracic segment as that portion only of the upper surface which lies between the wings. Thus it comes to pass that the dorsal plate of the prothorax occupies its whole breadth, both the grey and red portions, in my drawing (Fig. 4, Pl. V.), while the dorsal plate of the next fills only its central grey portion, and this brings me to my state-

ment on the opposite page, where it is marked with an asterisk.

I have already pointed out how absurd such a statement would appear in the case of the wood-louse; but does it appear less so in that of the cockroach? It appears to me to be only the circumstance of the separation of the wings in the perfect insect which renders it tenable at all; for in the earlier, as shown in Figs. 2 and 3, when the dorsal surfaces are as yet undivided, the difficulty of regarding the whole breadth of the pro-thorax, as corresponding with the central portion only of the next, would be as great as it was in the case of the crustacean. I cannot but think, therefore, that the pro-thoracic shield corresponds in its entirety, not to the dorsal plate only of the next, but to that plate plus the wings; in other words, that the *lateral projecting portions of this shield, darkly coloured in the plate, are the homologues of the tegmina and wings on the mesa- and meta- thorax.*

I have italicised these words as containing the pith of my conclusions, but the matter does not end here. If this be accepted, we have a standpoint from which to view the relations of the dorsal surface of the pro-thorax in other insects, the bearing of which on the disputed question of the collar of the Hymenoptera appears to me important. Again, the same reasoning will, I think, apply to the succeeding abdominal segments as was used in the case of the pro-thorax. If the lateral dark-coloured portions of the latter be homologous with the wings, just so will be the lateral portions, also coloured dark, of the former. To maintain the contrary would be as reasonable as to say that the lateral portions of the first three body-segments of the wood-louse were homologous with one another, and yet to refuse this character to the succeeding ones!

Finally, the subject suggests that the whole series of projecting edges of the dorsal surfaces in the crustacean are homologous with the similar portions of the insect, including, of course, those which on the meso- and meta- thorax are specially modified to form the wings.

I hope that some one of our entomological friends will be sufficiently interested to follow out what I have said, and if my reasoning is fallacious to show me wherein the fallacy lies. I fear I must be open to the charge of thinking myself right and every-

body else wrong, but I hope I would not do so against good evidence to the contrary.

The Microscope and how to use it.

By V. A. Latham, F.M.S.

Part X.—Injecting (*continued*).

Plate XIV.

The Dry Injection Emulsions are easily prepared and convenient in use. As they will keep for any length of time, they can be prepared in large quantities, and thus be ready for use at any moment.

Carmine Injection Emulsion.—Soak 1 kilogram of gelatine (the softer kind used in photography) in water for a few hours until thoroughly softened; drain off the water, heat the gelatine over a water bath until liquified; then add, drop by drop, 1 litre of strong carmine in ammonia. The mixture, stiffened by cooling, is cut up, and pieces packed in a fine piece of netting. Vigorous pressure with the hand under water forces the emulsion through the net in the form of fine strings. These are placed in a sieve, and washed until free from acid or excess of ammonia; collect and redissolve by heating. Pour the liquid then on large sheets of parchment which have been saturated with paraffin, and then hang these sheets up to dry in an airy place. The dried layers of the emulsion are easily separated from the parchment, when they should be cut into strips and placed where they are protected from dust and dampness. The carmine solution used in this emulsion is made as follows:—A strong solution of ammonia is diluted with from three to four volumes of water, and carmine added in excess. After filtering, the solution is mixed with the gelatine, and then enough acetic acid added to change the dark purple-red into blood colour. It is not necessary to completely neutralise the ammonia. The dry emulsion requires only to be placed in water for a few minutes and melted over a bath to be ready for use.

Blue Emulsion (modified from Thiersch's formula):—

1.—To 300 ccm. of melted gelatine add 120 ccm. of a cold saturated solution of green vitriol (ferro-sulphate).

2.—To 600 ccm. of melted gelatine add, first, 240 ccm. of a saturated solution of oxalic acid; then 240 ccm. of a cold saturated solution of red prussiate of potash (potassic ferryocyanide).

3.—Pour No. 1 slowly into No. 2, stirring vigorously; the mixture to be heated for fifteen minutes.

4.—After cooling, press the emulsion through netting, the strings washed, and spread on waxed paper for drying. In this case these strings must be dried directly, as they do not melt well without adding oxalic acid.

The dry strings, or vermicelli, are prepared for use by first soaking in cold water, and then heating with the addition of oxalic acid, enough to reduce them to a liquid.

Black Emulsion.—(1) Soak 500 grms. gelatine in 2 litres of water, in which 140 grms. of common salt have previously been dissolved, and melt the mass on the water-bath.

(2) Dissolve 300 grms. nitrate of silver in 1 litre distilled water.

(3) No. 2 poured very slowly into No. 1 while stirring. An extremely fine-grained emulsion may be obtained by using three or four times as much water in Nos. 1 and 2.

(4) No. 3 pressed into vermicelli, as above, and then mixed with No. 5 by clear daylight.

(5) Mix $1\frac{1}{2}$ litres of cold saturated solution of potassic oxalate with 500 ccm. of a cold saturated solution of ferro-sulphate.

(6) No. 4, mixed with No. 6, gives a thoroughly black emulsion, which should be washed for several hours, again melted, and finally poured in a thin layer on waxed paper. A grey-black emulsion may be obtained by using 240 grms. potassic bromide in the place of common salt in No. 1, the remaining operations being the same.

A good mass for Ordinary Injections.—Dry starch ("laundry" is good), 1 vol.; $2\frac{1}{2}$ per cent. aqueous solution of chloral hydrate, 1 vol.; 95 per cent. alcohol, $\frac{1}{4}$ vol.; some colour, $\frac{1}{4}$ vol. (The chloral and alcohol prevent fermentation when mass is kept,

alcohol increases fluidity, and hardening in the vessels, both act as a preservative.) Among the colours recommended are vermilion, red lead, etc. *To prepare the Colour.*—Take dry colour, 1 vol.; glycerine, 1 vol.; 95 per cent. alcohol, 1 vol. Grind thoroughly in a mortar, keep in a stoppered bottle, and it is prepared for use by simply shaking.

Osborne's Method of Injecting the Arteries and Veins (Pl. XIV., Fig. 1).—Two injecting fluids are employed, the first having a density that will allow it to pass the capillaries easily, while the second is of such a density that it will be arrested at the capillaries. The whole vascular system may be thus injected from the arterial bulb.

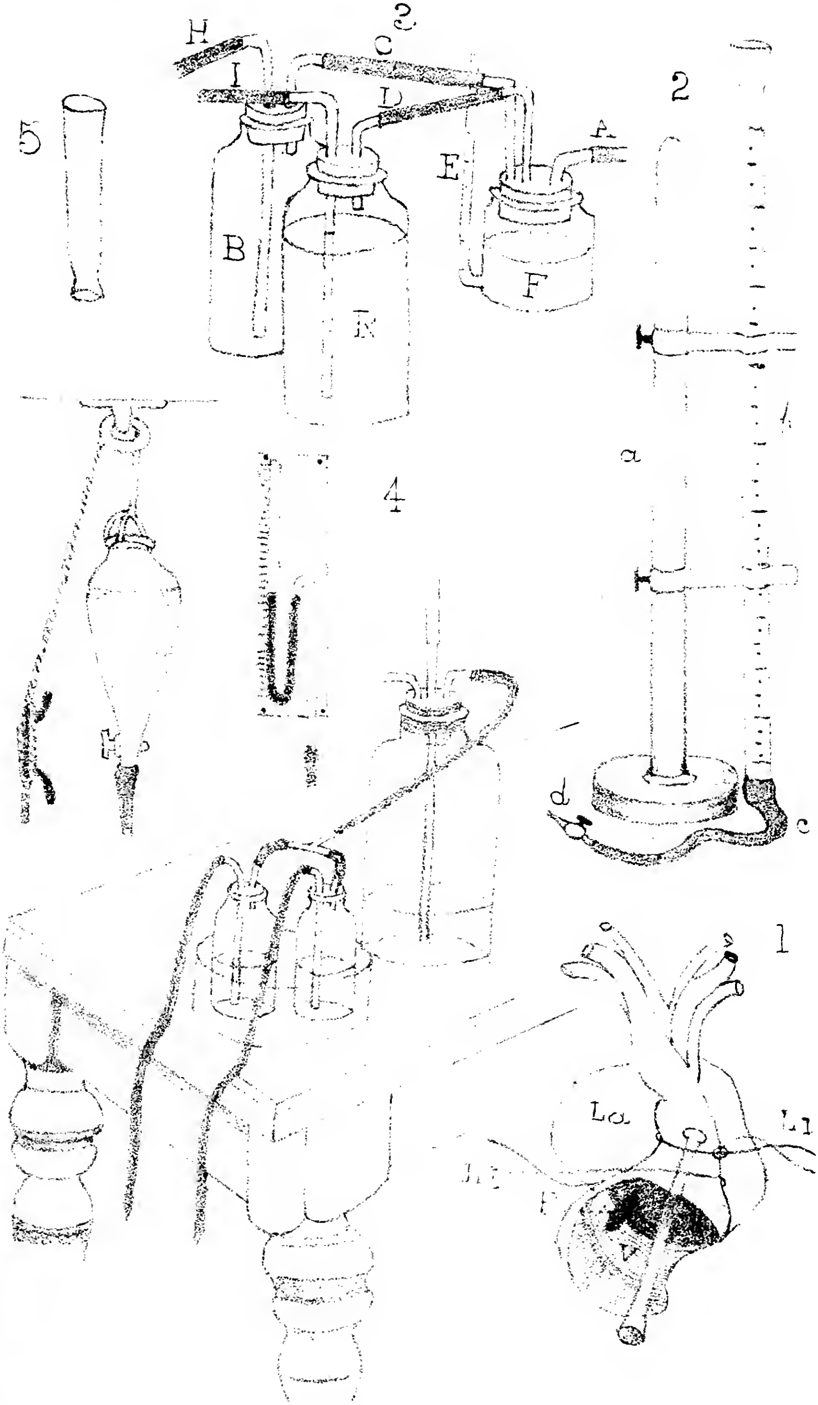
(1) The animal to be injected is immersed in tepid water, and the heart laid bare.

(2) The apex of the single ventricle, in the case of an amphibian, or of the left ventricle, in the case of higher animals, is then widely opened, and the blood allowed to flow from the auriculo-ventricular aperture.

(3) The cannula is now inserted, so that it reaches into the arterial bulb, and two ligatures made at the points indicated by L 1 and L 2.

(4) When the body is thoroughly warmed, an ordinary red or purple gelatine mass is slowly injected. The second ligature having been let loose, a quantity of blood, gradually flowed by the injecting mass, flows from the auriculo-ventricular opening.

(5) When the gelatine mass runs quite clear, the second ligature is fastened, and the syringe replaced by another containing red Plaster of Paris mass. The latter drives the gelatine mass before it as far as the capillaries. When the gelatine is well cooled, the animal is ready for dissection. This method can be applied with considerable ease to all the smaller animals, such as frogs, lizards, and pigeons, in preparation for class-work or investigation. It must be remembered that alcohol cannot well be used as a preservative, because it *dehydrates* the gelatine, causing it to shrink and break up the veins. This difficulty is entirely obviated, however, by using Wickersheimer's fluid, which keeps the injection for an indefinite time.



Injecting Apparatus

Goadby's Mass, which is modified from M. Doyer's recipe (Comptus Rendus, 1841).—Saturated solution of bichromate of potash, 8 fluid ozs.; water, 8 ozs.; gelatine, 2 ozs.; saturated solution of acetate of lead, 8 fluid ozs.; water, 8 ozs.; gelatine, 2 ozs. The majority of preparations thus injected require to be dried and mounted in Canada balsam.

The Syringe.—In selecting, the following points should be attended to:—(1) The syringe should be of at least one-ounce capacity, and furnished with two rings at its upper end, one on each side, for the fingers to pass through; (2) it should have three pipes, or cannulæ, of about 1/16 in., 1/32 in., and 1/64 in. in diameter; and in order that they may be secured firmly in the vessels whilst making an injection, they should be provided with a pair of arms to pass the ligature round; (3) the piston should fit the cylinder so accurately, that if the nozzle of the syringe be closed with the finger, or the piston be drawn up, it will, on being released, instantly return to its former position; (4) the syringe should be provided with a stopcock. The cost of such an instrument is about 15/-. If the beginner does not desire to go to so much expense, a glass syringe costing about 1/- will do very well. The cannulæ may be made out of glass tubing, by drawing it to a fine point in a Bunsen's flame, and then cutting off the part required.

Injecting Apparatus.*—Place some of the injection in a wide-mouthed glass jar on a shelf, about five feet above your table; cut two holes in the cork, which should fit the bottle accurately. In one hole place a small funnel, so that air may get to the interior of the bottle, and should the injection threaten to become exhausted before the completion of the process, some more can be poured in. In the other hole insert a bent glass tube, one end of which should reach in the inside of the bottle to the bottom; the other end may be left four inches long, and turned over in a good arch. On this end fit about six feet of india-rubber tubing of a size to tightly embrace the glass tube; in the distal extremity of this tubing fasten a small stop-cock. If now suction be made at this, the injection will flow out of the bottle down the tube;

* *Quekett Journal*, March, 1882, p. 17.

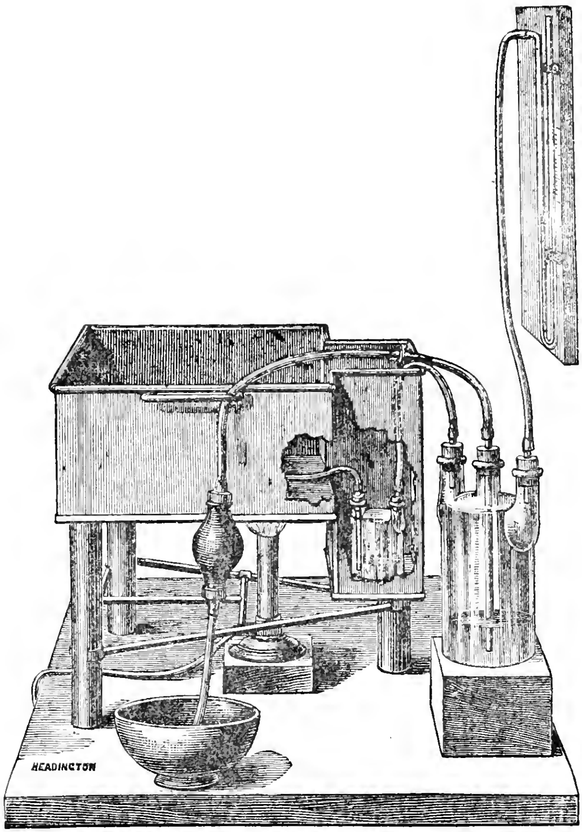
the stop-cock can be turned, and thus the tube will be charged without containing air. Choose now cannulæ of a suitable size to the vessel you intend to inject into. Dr. White recommends the specimen, after being saturated with the glycerine from the injecting fluid, only requires a little weak glycerine and camphor water to put it up in. It preserves many features that otherwise would have been blotted out.

A simple Injecting Apparatus is that shown in Pl. XIV., Fig. 2, the construction of which may easily be seen. The stop-cock (*d*) should fit into the aperture of the cannules of the ordinary injecting apparatus. The cannules should be tied into the vessel of the organ to be injected, and placed in a convenient position near the glass tube, having been previously filled to a certain height, and the stop-cock turned off. Insert the end of the tube securely into the aperture of the cannule and open the cock. The original pressure may be maintained or increased, as necessity may require. Its advantages are simplicity and that it may be left to itself for a number of hours or even days.

The most usual way of injecting the blood-vessels is by means of the ordinary syringe. This requires a great amount of practice. The animal has to be kept in hot water; the mass has to be kept hot usually in a separate vessel, and time has to be allowed between each syringeful for the fluid to penetrate. Then, again, if air gets in on introducing the point of the syringe into the socket of the pipe that is tied into the artery, the fluid will not run at all.

Fearnley's Apparatus.*—With this method no practice is required beyond introducing and tying in the nozzle in the aorta. There is a bath which has a shallow part for the animal to lie in and a deeper part for the Woulff's bottle, containing the injection mass, to stand in. A large (40 oz.) Woulft's bottle, with three necks, is fitted with three perforated india-rubber stoppers. The middle stopper is fitted with a glass tube, which goes to the bottom of the bottle. Each of the others is fitted with a glass tube the depth of the stopper only, and standing above the

* The accompanying engraving is given through the courtesy of Messrs. Swift and Son.



FEARNLEY'S APPARATUS.

stopper sufficiently to admit of a piece of india-rubber tubing (such as is used with infants' feeding bottles) being fixed upon it. The Woulff's bottle containing the mass has two necks, fitted with india-rubber stoppers. One neck admits a piece of glass tube, which goes quite to the bottom of the bottle. The other admits a short piece of tube, the depth of the stopper only. The illustration shows all further detail. The apparatus is made by Messrs. Swift and Son. The mercurial manometer allows five inches rise of mercury in the ascending arm, therefore five inches fall in the descending arm, though four inches will do. To inject the animal, proceed as follows:—Fill the bath with water, and heat the water with a Bunsen burner to 100° Fah. or so. The Woulff's bottle containing the mass should be filled and thoroughly stoppered. Then chloroform the animal and make an L-shaped incision into the thorax, so as to expose the heart and aorta. This is done by passing the knife up the middle line of the sternum nearly as far as the root of the neck; then make a second incision at right angles to this to the left of the animal. A triangular flap is thus made, and the heart enclosed in the pericardium exposed. Cut through the pericardium, seize apex of heart with forceps, snip it off. Thus the right and left ventricles are opened, and the animal instantly bleeds to death. The opening in the right ventricle leading to the pulmonary artery has a crescent shape or slit-like appearance; whilst the opening in the left ventricle, leading to the aorta, is round. Therefore, if desired to inject the *entire arterial* system, we insert our nozzle into the round hole; if the *pulmonary* system, into the crescentic slit. The nozzles are to be inserted into one or other of the two holes (usually the round one· to inject the entire arterial system with carmine and gelatine mass). We can now tie either artery only or the whole heart substance. In either case, a ligature of *floss* silk is to be used and tightly tied and secured. Now wash all the blood out of the cavity of the thorax to keep the bath-water clean; lift the animal into the bath and let it remain ten minutes or so to get well warmed. It is useful to slit open the entire abdomen in the median line, so as to allow the warm water to get freely around the viscera. The mass thus gets into every organ and every part of an organ evenly. Now connect the pres-

sure-bottle with the manometer and Higginson's syringe, as in the engraving; also with the mass bottle. The tube of this bottle, which conveys mass *away* from the bottle, is now clamped, and must never for a second get out of the warm water. Having a small basinful of water, squeeze the Higginson's syringe, watching manometer, to raise the mercury half-an-inch. This done, remove the clamp from efflux tube, and the red fluid, after driving out a few air-bubbles, begins to flow out. We at once make the connection, and all dangers are passed if we have tied our nozzles properly into the artery and connecting part, and fastened our stoppers thoroughly into our Woulff's bottles. Hold the head of the animal, which should be to the left, with the left hand to watch the pale gums, tongue, eyelids, and vascular parts become suffused with a pale blush, which gradually deepens; gently squeeze and relax the barrel of syringe, and glance at the mercury from time to time. When it has risen four or at most five inches, the animal will be completely injected. The visible mucous membrane and intestines will be *dark* red and much swollen. Remove the animal, place in ice-cold water or under the tap for an hour or two, and divide into parts as required. It is best to prepare the injection masses immediately before they are used; but they can be kept for some time, I find, if chloral be added to the gelatine. Before being used, the mass should be always carefully filtered through flannel.

Haye's Method of Double Injections.—Fit a cannula into the aorta of a cat, and inject a gelatine mass coloured with carmine until it is seen flowing from the right side of the heart; then detach the tube conveying the red mass; slip one containing a blue gelatine mass over the same cannula, and apply the pressure again. Into this blue mass is mixed thoroughly a quantity of starch—preferably from wheat. This starch-mass pushes the carmine mass before it until the starch-grains enter the capillaries and effectually plug them up. The arteries are left blue and veins red. The first mass injected need not be unusually thin. The capacity of the capillaries is so great, compared with that of the arteries, that any commingling of the two colours is concealed in them. Carmine is used for the veins because of the ease with which it is prepared, its permanence, and the facility with which

it passes through the capillaries. Again; the gelatine for the arteries may be coloured with coarser pigments, such as Prussian blue or ultramarine. The latter furnishes a beautiful blue. A plaster of Paris mass injected after a gelatine mass will drive it on until the plaster reaches the smallest vessels, thus producing a double injection. The usual method of double injections is to first inject a gelatine mass of one colour into the artery until increasing pressure gives notice that a mass is entering the capillaries, and immediately after inject a different coloured mass into the vein. A better way is to fill both vessels at the same time and under exactly the same pressure. The pressure is kept low at the beginning, so that all the arteries and veins shall be thoroughly filled before either mass begins to enter the capillaries. As the pressure is increased, the different masses meet each other in the capillaries, and, if the pressure on each is equal, the vessels may be filled as full as compatible with safety, without danger of either colour being driven from one set of vessels into the other. This will be better understood by referring to the drawing (Pl. XIV., Fig. 3). The desired pressure is secured by letting a stream of water from a hydrant or elevated vessel flow into a tight vessel. As the water flows in, the air is forced out through the rubber tube, A, into the wide-mouthed bottle, F; through the close-fitting cork are two other glass tubes. Those extend below just through the cork, and above connect respectively with the rubber-tubes, C or D. Into the side of F, near the bottom, is fitted another tube, E, reaching to a height of ten inches or more, open above, and graduated into inches. If preferred, this tube may also pass through the cork and extend down well into the mercury, with which F is partly filled. B contains a blue injection mass for filling veins, and R, a similar bottle, a red mass for arteries. The interiors of these bottles are connected with bottle F by tubes D and C. Each of the bottles B and R has a tube, which, starting from near the bottom, passes through the cork, and is, a little above this, bent at right angles. Connected with these are rubber tubes, H and I. When the water is allowed to flow into the reservoir, the air is forced out through A into F, thence along tubes D and C into B and R. As soon as the pressure in these bottles is sufficiently great, the liquid which they contain will be driven out

through the tubes H and I. If there is any obstacle to the escape of the fluids, the pressure in all the vessels will rise and be registered by the height of the mercury in E. To inject, for instance, the *kidney of a pig*, a cannula made of glass tubing must be fitted securely into the renal artery, and another (same size) into the renal vein. H and I tubes must fit the cannulæ well. Heat the masses in B and R to a proper temperature, and keep them so heated until the injection is finished. Special care must be taken with tubes H and I to prevent gelatine passing through being frozen. Now clamp H, and let an assistant turn on a small stream of water until the gelatine begins to flow slowly from I. If the diameter of the cannula is not too small, it may be held with the free end up and filled with gelatine, allowed to drop from the mouth of I. Then slip I over the cannula and unclamp the tube H, and when the gelatine from B begins to flow, slip it over the cannula inserted into the vein. Increase the pressure gradually until as high as experience has taught to be safe for the organ. I have tried this method as recommended on the kidney, the arteries and glomerule being uniformly filled with the red mass, the veins and the system of capillaries surrounding the renal tubes being filled with blue. The lungs and liver are easily well injected. Triple injections of liver are made by first injecting the hepatic artery with a green mass until the whole liver assumes a green tint, and afterwards injecting the portal vein and the hepatic vein with red and blue, as above directed. The same apparatus may be employed for single injections or the double injection described on page 106, by simply clamping one of the tubes C or D. As a matter of course, care must be taken that all the corks fit tightly in the bottles, otherwise internal pressure may force them out at the very moment when an accident will do most damage.

Half-an-Hour at the Microscope
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Parasite of Gull, Docophorus Platygaster.—The limbs of the insect require careful study, the head with the mouth organs, etc., and especially the wavy markings of the integument

like those on some ticks and arachnida. Two moveable appendages, one in front of either antenna, near its base, must be carefully noted. They are called "trabeculæ." I take them to be homologous with the "First pair of Antennæ" in Crustacea, and shown us as large moveable organs in *Daphnia pulex*, here but rudimentary.

Gizzard of Flea.—The delicate membranous part, looking like a little bag without strings, is a portion of the crop, whereinto the blood is pumped during one of the creatures' thoughtless drunken bouts. Thence the food passes into the bowl-shaped middle portion, the gizzard proper. This is lined with teeth, arranged in quincunx with beautiful regularity; the bases of these teeth appear like fish-scales in the lower part of the bowl, tending more or less to a hexagonal outline as they approach its margin. The points of the teeth project forwards, the whole forming a powerful mill for grinding blood-corpuscles, some of which may be seen in a triturated state along with hæmatin in the instructive specimen now before me. Endeavouring to compute the number of teeth, from three professionally-mounted specimens in my possession, there appear to be, as nearly as I can make out, just 500! It is probable important differences may present themselves in fleas taken from our beds, or from the cat or dog. The long tapering tube pendant from the gizzard is the first part of the intestine; the dark patches I take to be biliary glands in a simple form. To complete our knowledge of this object we want a specimen mounted, so that we may look into the gizzard from above, and another laid open lengthwise to show the teeth.

Hippobosca equina belongs to a small section of the Diptera, whose place in a natural arrangement is at the very end of the true insects, and leading directly to the ticks, amongst the acarine division of the arachnida. The section includes but two families —the *Hippoboscidæ* and the *Nycteribiidæ*. The latter family appears to contain but one British genus with a single species parasitic on bats, an anomalous, wingless, spider-like creature, of which specimens are in the collection of the British Museum. It may be considered certain that special search amongst bats of various kinds from different countries will be repaid by many more forms of these remarkable creatures. To the Hippoboscidæ belong the swallow-fly—*Stenepteryx Hirundims* (easily recognised by its long, narrow-pointed wings), the Sheep Tick, *Melophagus ovinus*, and a few others, which are mostly parasitic on birds. Search should be made for them by our members whenever opportunity offers. The bare enumeration of the points of structure demanding careful study in this beautiful creature would be like a mere *Catalogue raisonné*, for nothing in

it can be passed over without loss of knowledge. Antennæ; eyes (having crustacean-like, square facets); ocelli; trophi (most singular and puzzling, yet yielding important information); spiracles (seven pairs); the powerful thorax; the singular wings; the balancers; and the ovipositor.

The thick fleshy organ on one side in front is the *labium;* the part in the centre which lies uppermost is the labrum; this fits over a cavity along the top of the *lingua.* Into grooves in the sides of the lingua fit the *maxillæ;* they are enclosed by long, narrow, somewhat spoon-shaped organs, the *mandibles;* the whole being shut in and protected at the base by the pointed, fleshy, external organs, the *labial palpi.* The ocelli should also be noted. The metallic zonal colouring of the eyes is very splendid.

In connection with the limbs, their massive character, the tripartite claws, the apodéme, for attachment of the long flexor tendon, looking like a pair of combs arranged back to back; the series of tenent hairs on the pads; the long, plumose, tactile hairs between the latter; and the mode of articulation of the hairs on the abdomen, recalling the arrangement of the same parts in the Arachnida—all these points require critical attention. I never had to work over an object in which it was so difficult to grapple with and master the entire details. As opportunity offers allusion will be made to these on future occasions.

Head of Horse-Fly.—Being mounted without pressure, I look on this slide as *a type of the slides of the future!* The antennæ, however, should have been removed, and placed on the slide in front of the head; their form is very characteristic. Such should be fixed in their places with a little solution of gum tragacanth in weak acetic acid. "Go on and prosper" is the best advice that can be given. Study nature, and endeavour to preserve, as far as may be, the beauties present to the educated eye in all natural objects.

Selected Notes from the Society's Note-Books.

Stenocephalus agilis.—Without having devoted much thought to the subject, I have always had a feeling that the function attributed to the saw-like organs of the so-called "Saw-flies" of sawing a hole for the deposition of their eggs could scarcely be correct, and the observation of this creature, in which these organs are so very beautifully developed and so admirably shown on the slide, goes far to confirm me in this view. The organs as seen do not

appear to me adapted to the reputed function, and I would suggest if their peculiar form be not rather intended for the guiding and retarding the otherwise possibly too rapid extrusion of the eggs. Here the structure may be followed far beyond the possible extrusion of the organ from the body of the creature, though somewhat modified. W. CASE.

Gizzard of Flea.—In reference to Mr. West's remarks on the Flea's gizzard (see p. 112), I may say I have two prepared as he suggests: one was cusp-shaped, and fixed with the mouth upwards, so that I could see that the interior was lined with fibres apparently rooted near the bottom. On applying some pressure, it opened into a circle of fibres too numerous for counting. These, I suppose, are what Mr. West terms teeth—a name, I think, not applicable. Another gizzard is laid on its side, and here the fibres bear out my opinion that they are not teeth in the ordinary sense of the term. A. NICHOLSON.

Trichocolea tomentella.—The fructification of *T. tomentella* is small, black, and nearly spherical; it was lately shown me by the President, who had found it in a damp wood. After a few minutes' exposure in a warm room, its valves expanded (whether 3 or 4 I cannot say), and under the microscope a brown surface was seen—with the spores flying off in all directions—thrown off by the elasticity of the elaters. C. P COOMBS.

Negro Skin.—In 1870, when skin grafting was introduced from Paris, a piece of Negro-skin was grafted on to the body of a white man. The sore healed, and (I believe) the neighbouring skin received the dusky colour. C. P. COOMBS.

Burweed.—Several species of plants possess hooked spines on the fruits, or seeds, by which they are carried about attached to the fur of animals. Mr. Maynard's specimen (see p. 56) is, perhaps, from *Xanthium spinosum*, a plant something like a *Chenopodium*, but with spinous leaves, occasionally found in waste places in the woollen districts of this country.

H. F. PARSONS.

Head of Empis.—In a recent note (*Journal of Microscopy*, Vol. V. p. 240), Mrs. E. M. West speaks of the mandibles as attached to the extremity of the long snout, which serves as a case for the other parts of the mouth when not in use. Is this correct? My belief is that the organs which she thus describes are a spinalised form of the extremity of the labrum; and for the following reasons:—

1.—The mandibles in the Hymenoptera and Neuroptera when they are highly developed are attached to the cheeks. In the Empis the organs in question are attached to a piece, which is jointed on to the clypeus, and beneath which is the lingua (a large dagger-like organ, the end of which is correctly indicated in Mr. West's figure by the letters *lg.*) This is the position occupied by the labrum in most insects.

2.—The extremity of the labrum is frequently variously cut and notched in the diptera, and is frequently extremely prolonged in the Tabanus, or Horse-fly.

3.—The organs in question do not appear in the living insect as represented in Mr. West's figure, in which they have been flattened out. In the living insect the bristles (not teeth) with which the outer edge of the organs in the figure is armed are beneath the organ, and parallel to each other—*i.e.*, seen in profile, not from above, so that when closed they form a kind of net.

In one instance (a neuropterous insect, the name of which I do not know) the head is prolonged into a snout, and the mandibles are at the extremity, but in this case the maxillæ, and lingua, and labium, are all also at the extremity of the snout. If this, then, be an instance of the mandibles at the end of a snout, and the other parts attached to the base, it is the only instance I have met with in any order. GEO. CREWDSON.

Hybos grossipes belongs to the very large family of *Empidæ.* —The Empidæ are common in the spring and early summer; towards autumn they become rarer. They are a very interesting family on account of the peculiarity of their mouths and antennæ. Let alone the general build of the fly, an Empis can always be recognised by its antennæ, which are invariably of the characteristic "steeple" shape. (See *Journal Micro.*, Vol. IV., Pls. V. and VI., Figs. 6 and 7.) H. M. J. UNDERHILL.

Slides of Crystals.—I do not agree with those members who think that these slides "teach little." In my opinion, the formation of a crystal is a subject for deep thought. Let us suppose a Cubic Crystal to be under inspection. As time goes on it increases in size, but is still a cube; how is it increased? Is it by adding layer to layer as we plaster the walls of our houses, or is it by adding cube to cube as we build our chimneys by adding brick to brick? and if so, what was the size of the original germ? In fancy I can see it so very minute, that it may be fairly described as a *square mathematical point* having neither length, breadth, or thickness, and yet consisting of a solid, enclosing the water of crystallisation, and these are the bricks which form the slides of Asparagine, Santonine, and Salicine. A. NICHOLSON.

Algæ.—I noticed a short time ago that boiling water changed a *red* algæ to an olive-green colour. This seemed to me to be curious. I shall be glad to know the precise effect of heat on Chlorophyll. H. M. J. UNDERHILL.

Crystallisation.—What would a mathematician say of a "cubical point" capable of containing something within it? I imagine that Mr. Nicholson does not hold that matter is formed of atoms. The Atomic Theory beautifully explains many of the phenomena of chemistry, but does not explain crystallisation. *If* a substance did consist of atoms, the "original germ" would not be cubical. We can understand that homogeneous substances, as water H.O.H., and common salt (Sodic chloride), Na. Cl., might arrange themselves into symmetrical forms, but it is difficult to comprehend how some of the more heterogeneous compounds, as, for a familiar example, Citric acid, which is—

$$\begin{cases} C\ H_2\ (CO\ Ho) \\ C\ H\ (CO\ Ho) \\ C\ H\ HO\ (Co\ Ho), \end{cases}$$

can arrange themselves symmetrically unless we suppose that the force of cohesion acts, not equally in all directions, as gravitation does, but in certain directions only.

F. J. ALLEN.

Cupric Acid.—My method of making these crystal slides is—I am particularly careful to have the glass-slips *perfectly* clean and free from grease, by wiping with Liq. Ammonia or Liq. Potash. I then make a solution in water of the sulphate, in an equally clean glass tube. I now hold the slip over my micro lamp until it is almost too hot to touch, and then, with a clean glass rod, spread a drop of the liquid (not too much) in the centre of the slip. When it begins to steam, I gradually raise the slip from the lamp, thus lessening the heat, and in a second or two the liquid will have become dry, and the spirals formed. As soon as the slip has cooled, I mount in Dammar, and have not yet (18 months) noticed signs of deliquescence. I do not succeed with every slide, but think I get a fair average success. J. M. WILLIAMS.

Sections of Mountain Limestone.—I must explain how it is that some sections are thick. In making cuttings, only about one specimen in three contains something interesting, and perhaps a third of the best ones break during the process of grinding, and the cracks come at the junction of shells, etc., with the crystalline limestone. I therefore generally cease to "thin" when the section is moderately transparent. If the rock is successfully ground to extreme thinness, the nature of many of the objects cannot be well seen, for the crystals of the carbonate of lime attract the eye everywhere. I will endeavour to explain the dif-

ference thus :—If you look at a room through the window, you can see a great deal of everything therein ; but if one were to see only a thin section of any part, all that would be noticed would be the walls, the profile of mantel-piece, of some part of a chair, a table, etc. In like manner one can recognise the shape of a glass tumbler when one sees it whole, but a section merely shows |__| ; hence it is that a section of wood made longitudinally is better when thick than when made very thin. In one case one can well recognise the nature and size of the dotted ducts ; in the other one merely has a serrated outline, . Of course, one must always seek to get sufficient transparency to permit light to pass. I have a beautiful section of jet, which shows lines radiating in all directions from a centre towards the eye—away from it and laterally ; but these can only be shown by a strong light condensed. If I were to thin the specimen, I should lose either the centre or the lines which radiate to or from the eye.

J. INMAN.

———

Glycerine Jelly *v.* Canada Balsam for mounting Entomological slides.—I am glad to find that some agree with me that "clearness of specimens is not the perfection of mounting." Let anyone mount two specimens of the same object, one in C. Balsam and the other in G. jelly, and compare them. The Balsam one will be perhaps as clear as glass, of a very pretty colour, varying between amber, yellow, and sepia ; the Glycerine jelly mount will at first-sight look woolly, and not nearly so pretty in colour as the former ; but on closer inspection, the jelly mount will show far more detail than the other. The woolliness is *not* in the jelly, for it is as clear as the balsam, nor is it dirt, for the effect is the same in the most perfectly cleaned specimens. It must, therefore, be in the objects themselves, and surely no one would willingly conceal the characteristics of his specimens for the sake of prettiness.

F. J. ALLEN.

———

Cement.—Brunswick Black and Gold Size in equal proportions I have found a worthy cement for fastening down covers on cells in dry mounts. It is far superior to Brunswick black alone, and is a cement requiring little or no trouble in preparation. I have tried it for glycerine jelly mounts, and in *most* cases it has answered well. It is best for this class of objects if the size is *old* when mixed, as it is not so fluid, and therefore less liable to run in.

J. C. HOPE.

———

Cement.—Kay's Coaguline is in my opinion the best for fixing cells and for dry mounts. I find it is often desirable to put a ring of it on slides other than dry mounts, thereby cementing together both cover and slide. The advantages of coaguline are—1. That,

it is very easily worked by putting the bottle in hot water. 2. That it sticks well. 3. That it is almost transparent. For fluid mounts and glycerine jelly, I use Bell's cement, which answers very well, but I always finish off with a coat of coaguline.

W. SARGENT, Jun.

Pitchstone, from Arran, is a very remarkable rock which forms veins and dykes intruding amongst the sandstones of the Island. It varies in colour, and also in its contents, but speaking generally, it may be described as a clear glassy base, which has been considered to be a vitreous state of Felsite rock. This base is densely crowded with minute crystals (Belonites, or Trichites) of Pyroxene or Angite. These are sometimes straight needles, but are also frequently disposed in beautiful fern-like groups. Besides these Belonites, the base also sometimes encloses crystals or granules of Quartz, also crystals of Sanidine, and laminæ of Mica, together with strange little balls of Felsite (?) J. M. MELLO.

Feet of Fly.—I believe it to be an established fact that flies' feet are *not* suckers, but merely what they seem to be—brushes, the hairs of which give out a liquid. However, neither the experiment with powder, nor the fact that if you breathe on glass, a fly cannot walk on it because of the moisture, appear to prove to me that the pads are *not* suckers. Supposing that they were suckers, I think that just the same effects would be produced. Mr. Blackwall's statement (if true, which cannot be doubted) proves the fact that the hairs exude moisture. He says, that if the "track" made by a fly on a piece of glass be examined with a high power, footprints (so to speak), formed by moisture, may be detected. Of course, if a fly leaves moisture behind it, it must have exuded it, and, as far as I see, there is no need for this fluid to be glutinous. If merely viscid like glycerine or oil, it would stick just as well. Let any observer try to remove one piece of wetted glass from another, by pulling it away in a direction perpendicular to the surface, it will require very considerable force to remove it; but let him lift up one end first, and it can be done with ease.

H. M. J. UNDERHILL.

Hind Leg of Ailantus Scrophulariæ, one of the common green Sawflies.—This slide has been specially prepared in furtherance of the discussion on the Feet of Flies. The foot has not been treated with Liq. Potassæ, therefore, it retains its natural appearance to a considerable degree, and has not even lost its original green colour. In order to get a correct idea of insects' feet, they should be examined *dry* and *fresh from the insect*, or mounted in fluid *without treatment by alkali.* Liq. Potassæ dissolves out some of the essential parts, and balsam gives the pads the appearance of

amber spoons, thereby favouring the sucker theory. The present specimen was taken from an insect which had been killed by immersion in methylated spirit, and kept in the same for twenty-four hours. The spirit serves more purposes than one—*e.g.*, it displaces the air from the cellular structures, and by its antiseptic properties prevents after-decomposition. After removal from the spirit, it was immediately washed in water and mounted in jelly. The claws and pads are unpacked to their full extent, and may, therefore, be examined to advantage. The *pad between the claws* is not covered with long viscid hairs, and those who support the simple sucker theory will think this is in its favour ; but, nevertheless, it is covered with short hairs, which, even if they are not viscid, must interfere with the action of the suckers.

The pads on the *underside of the joints* are of a different character, and are covered with long, viscid hairs, like the pads of Diptera's and other insects' feet. I should like to know how such pads as this can "suck," for even if each hair have a separate sucker, I do not think there would be surface enough on three feet of a blue-bottle or a gnat, to support it on a perpendicular glass window, whereas they seem to have no difficulty in walking up a window, though they must at times have three feet off the "ground" at once.

F. J. ALLEN.

Eozoon Canadense.—This is a Foraminifer, or rather the fossilised and partly metamorphosed remains of one, which is not only gigantic in size, but also represents all that is yet known of the earliest forms of animal life on the globe. The shape of the Foraminifer is not known, but it certainly attained upwards of a square foot in size, and was several inches thick ; its mode of growth was zoophytic, related in this respect to the Polycistina. The original shell is represented by the calcareous layers, while the sarcode is represented by the serpentine and other silicates which fill up the imperfectly separated chambers of the shell. This latter characteristic resembles that of *Carpenteria*. This remarkable fossil was first discovered by Dr. Wilson and others, and pronounced to be an organic form by Sir W. Logan. It was found in the Lower Laurentian Limestones of Canada, and is, therefore, as I have said, the oldest fossil in the world.

J. M. MELLO.

Lepidolite.—The commonest form of this mineral is seen in those thin laminæ, sometimes used as smoke-consumers for lamps. It contains lithia, as that substance is shown by the use of the spectroscope.

J. M. MELLO.

Cement for Finishing Slides.—Take dry white-lead (flake-white) and crush fine with a spatula, or old table-knife, and as much turpentine as will make a thick paste, then grind fine.

Something is then wanted to bind the colour together when dry. Dammar or Canada balsam will do, but neither are so good as Copal varnish. Several kinds of this varnish can be had at the oil and colour shops, but for this purpose it must dry without heat, and be free from colour. That which is known in the trade as *Lamp-head* varnish is the best, it dries in about two hours; *Cabinet* varnish is good, but rather longer in drying. Spirit varnishes are worthless for this purpose, as they are brittle. About an equal bulk of varnish should be added to the colour; if less is used the work will look dull, if more is used the colour will be wanting in *body*.

Before proceeding to lay on the coloured ring, it is a safe plan to put on two or three coats of something which will prevent running in. I have used two coats of Copal varnish, each to be well dried before laying on another. I have also used a varnish made of shellac dissolved in methylated spirit, and, as this is brittle, I add about one-eighth gutta percha. This is a useful cement for gelatine and glycerine mounts. The rings should have one or two coats of pure varnish as a finish. THOS. LISLE.

Saws of Saw-flies.—Saw-flies are of the order of Hymenoptera; they are separated from the Bees and Wasps by the fact of having the abdomen united to the thorax by its whole breadth, instead of being merely connected to it by a short tube or a foot-stalk. Their mouths are not unlike the mouths of wasps, but their construction is simpler, the labium (lower lip) not being so highly developed, although considerably more complicated than the labia of beetles. The family of the *Tenthredinidæ* are true saw-flies; but I believe that the corn saw-fly, *Cephuspygmæus*, is a connecting genus between the *Tenthredinidæ* and the *Siricidæ*, whose ovipositors are more like the ovipositors of the *Ichneumonidæ*. The mouths of *Siricidæ* are very small; the mouth of *Sirex gigas*, or Giant saw-fly, which is the largest of the Hymenoptera, and bigger than a hornet, is *much* smaller than the mouth of the common wasp. Indeed, its parts are so rudimentary, that I doubt if the insect ever eats, or if it does it can eat but little. I have, however, no direct evidence on this point. I believe the saws of the genus *Lyda* are adapted for cutting very soft leaves, for the teeth are very large, and their form, which is not only that of teeth along the edge, but of projecting ribs from the blade of the saw, seems admirably adapted to prevent them from clogging. It was stated in *Science Gossip*, some years back, that the egg does not, as was formerly supposed, come down between the blades of the saws, but that it is laid by a proper ovipositor, which is like the ovipositors of the Diptera. I regret that I have never dissected a saw-fly with sufficient care to prove this statement, but I have little doubt of its truth. H. M. J. UNDERHILL.

Reports of Societies.

[*We shall be glad if Secretaries will send us notices of Meetings of their Societies. Short abstracts of papers read, and principal objects exhibited, will always be acceptable.*]

COUNTY OF MIDDLESEX NATURAL HISTORY AND SCIENCE SOCIETY.

AT a Meeting of the "County of Middlesex Natural History and Science Society" held at the Townhall, Kilburn, on December 21st, 1886, about 60 members being present, Mr. W. Mattieu Williams, F.R.A.S., F.C.S., was elected to the chair, and after the business of the Society had been transacted, the following papers were read :—

"Some Curious Facts connected with the Evolution of the Eye," by Mrs. Bodington ; and "Notes on Flora met with on the occasion of the Excursion of the Society to Hampstead, with Special Reference to that of Caen Wood," by Dr. H. J. Wharton, M.A.

In the discussion which followed, Mr. Lant Carpenter spoke upon the depths to which light penetrated in the ocean, and referred to the size of the eyes in deep-sea fishes.

Mr. Sydney T. Klein gave some interesting notes on the "eyeless" fish of the Mammoth Cave of Kentucky, which he had visited, and called attention to the Ocelli of Hymenoptera, some fine examples being shown by him under the microscope.

The Chairman, Mr. W. Mattieu Williams, made an ingenious and interesting suggestion that the Ocelli were for the appreciation of neither light nor sound waves, but for those vibrations which lie between these extremes, pointing out the enormous distance which lay between the highest sound and the lowest visible ray.

Mr. James Smith exhibited a curious example of a compound eye of a fly, in which the facets in the lower half were of different size to those of the upper part.

Mr. E. M. Nelson, a section of eye of rat and the eyes of a spider. The former was a marvellous example of successful injection, the finest ramification of veins remaining quite perfect.

Mr. Charles Rousselet, a larva of Hydrocampa nymphœalis.

Mr. Charles D. Sherborne, a large and very perfect trilobite ; also section of coal showing sporangia.

Dr. F. A. Walker, a case of Neuroptera, etc.

A vote of thanks to the Chairman terminated a very successful and pleasant evening.

Some Fine Slides.—Mr. Anderson, of Ilkeston, has sent us six exceedingly well-mounted slides, viz.—Earwig, Garden Spider, Dung Fly, Mole Flea (Male and Female on same Slide), Ground Beetle, and Larva of Drinker Moth. We are not sure that we have met with better specimens of whole-insect mounts.

Reviews.

Handbook of Practical Botany, for the Botanical Laboratory and Private Student. By E. Strasburger. Edited from the German by W. Hillhouse, M.A., F.L.S. Revised by the Author, and with many additional Notes by the Author and Editor. With 116 original and 18 additional illustrations. 8vo., pp. xxiv.—425. (London: Swan Sonnenschein & Co. 1887.) Price 9s.

This will prove a valuable book for the Botanical student. It is divided into 32 chapters, each of which will furnish practical work for several hours in the laboratory. Good and clear instructions are given for preparing all the various parts of the plant for microscopical study. We find also some important chapters on the lower form of plant-life. The greater part of the illustrations have been drawn by the author from nature.

American Medicinal Plants: An Illustrated Descriptive Guide, by Millspaugh. (New York: Bœricke & Tafel.)

We have much pleasure in acknowledging the 5th fascicle of this most valuable work. This volume contains illustrated descriptions of 30 plants used in medicine. Each plant is represented full-size and coloured to nature, the size of plates being 9 in. by 12 in., and are accompanied by generally four pages of letterpress, in which will be found—The Natural Order of the Plant, its Tribe, Genus, its place in the Linnæan System, Synonyms (if any), and Common Names. Then we have a general description of the plant under notice, and of the genus to which it belongs; its history and habitat; parts used in medicine, and method of preparation; chemical constituents; and physiological action. Only one fascicle now remains to complete this fine work; it is promised very shortly.

An Elementary Text-Book of British Fungi. By Wm. Delisle Hay, F.R.G.S. 8vo, pp. vii.—238. (London: Swan Sonnenschein & Co. 1887.) Price 15s.

This work deals exclusively with the larger kinds of Fungi, and after describing the characteristics of Fungi generally, their Economic use, Structural Anatomy, and Classification, devotes a larger space to the edible kinds, of which 221 species are fully described. The author is most anxious that Mushrooms should be more extensively eaten than they now are in England, and gives 133 recipes for preparing them for table. It is to be regretted that an article of food so nutritious and so easily obtainable should be so generally neglected, and Mr. Hay will have done good service if he excites an intelligent interest in the matter. At the end of the book are 64 well-executed plates, with descriptions opposite.

The First Book of Botany: a Practical Guide in Self-Teaching; Designed to cultivate the Observing and Reasoning Powers of Children. By Eliza A. Youmans. Crown 8vo, pp. 158. (New York: D. Appleton & Co. 1886.)

A really valuable little book for teaching the first principles of Botany to Children. It lays the foundation for a study of botany in the only true way, by providing for the actual and ready study of the plants themselves. The pupils are taught to observe the different parts of plants, and to apply to them the correct scientific terms, which by constant use become easy to remember. The book contains 249 good engravings, in which the different parts of the plants are very clearly described.

EASY LESSONS IN BOTANY according to the requirements of the New Code. By Edward Step. With 120 Illustrations, pp. 48. (London: T. Fisher Unwin. 1886.) Price 7d.

This little book appears to be very nicely adapted for the instruction of children. It treats the subject very thoroughly, and at the same time in a simple and understandable manner. The illustrations are good, and well explained.

OUR WOODLAND TREES. By Francis George Heath, Author of the Fern World, etc. New edition. Crown 8vo, pp. xx.—572. (London: James Nisbet & Co. 1887.) Price 7s. 6d.

A book beautifully got up, and most interestingly written. The author, whose aim is to enkindle a love of Nature in the hearts of his readers, has divided his book into four parts: Part I. treats of the Life of a Tree: its Germ, Early Growth, Structure, Development, Perfection, and Beauty; II., describes some Woodland Rambles; III., treats of Trees at Home; and IV., of British Woodland Trees.

There are a number of uncoloured plates, eight coloured, and several smaller engravings.

SYLVAN SPRING. By Francis George Heath. With twelve coloured plates. Crown 8vo. (London: James Nisbet & Co. 1887.) Parts I. and II.

Lovers of the country will find much to interest them in the work before us. It is arranged to be published in six monthly parts, at one shilling each. In addition to the twelve coloured plates there will be sixteen full-page wood engravings, and a great number of smaller illustrations interspersed amongst the text.

SPUTUM: its Microscopy, and Diagnostic and Prognostic Significations. Illustrated with numerous Photo-Micrographic and Chromo-Lithographic Plates,. By Francis Troup, M.D. 8vo, pp. 268. (Edinburgh: Oliver & Boyd, 1886.) Price 15s.

This fine work goes very thoroughly into the subject of which it treats, commencing with the Microscope and Photo-Micrography, with instructions for its practice, and followed by the subject-matter of the book. It is splendidly illustrated with six Chromo-Lithographic, and 36 Photogravure plates, all being of the highest class of excellence.

THROUGH A MICROSCOPE: Something of the Science, together with many curious observations indoor and out, and directions for a home-made Microscope. By Samuel Wells, Mary Treat, and Frederick Leroy Sargent. Post 8vo, pp. 126. (Chicago: The Interstate Pub. Co.)

This little book is intended for very young people, and contains much that is instructive, especially when it treats of Fresh-water Life; but we can scarcely think the author (or authors) to be quite in earnest. When describing the microscope, the child is told "To understand this, take out one of your eyes and look at it with the other one, ... and if you hold a doll or anything else about ten inches in front of the eye you have taken out, and look at the inside of it (the eye, not the doll) you will see the doll upside down on the back of the eye."

We learn from this book, also, that the citizens of Boston have only to turn on their domestic water-taps to obtain nearly every variety of fresh-water life; and also that these animals are just as good eaten raw as when cooked.

Catalogue of Microscopical Collection: arranged by R. H. Ward, A.M., M.D., F.R.M.S. (Troy, New York.)

This is a handsomely bound 4to vol. of ruled papers, in which a full record of all the slides in one's private collection may be entered.

Each double page, as the book lies open, is designed to record the following particulars of ten slides, viz.—Common and Scientific names; Special Points shown; Illumination; Power required; Reference to authorities; Habitat; How obtained; How preserved and injected; How cut, stained, cleaned, etc.: Mounting medium and Cement used; Thickness of cover-glass; Date; Number in Cabinet, etc. etc.

At the end of the book will be found blank pages for Memoranda, Recipes, etc., and an Alphabetical Index.

The Catalogue is certainly the most comprehensive and complete of the kind we have ever met with, and is evidently the outgrowth of the doctor's long experience and needs as a microscopist. We only wish we could have met with such a one ten years ago.

It is handsomely half-bound in morocco, with cloth sides; the price for one arranged of 1,000 slides is $4, for 2,000 slides $6.

For larger collections the Appendix is found to be more convenient if bound in a separate volume. We have received for sale a few of the 1000 edition.

Studies in Microscopical Science. Since our last issue we have received Nos. 5, 6, and 7 of these important studies. Sec. 1, Studies in Vegetable Physiology; No. 5, Treats of Storage Cells and Reserve Food Material, illustrated with slide and plate of section of Cotyledon of Pea (*Pisum sativum*); 6, Protoplasmic Continuity, illustrated by a longitudinal section of sieve-tubes of Vegetable Marrow (*Curcubita pepo*); 7, Hausteria, illustrated by a section of Dodder in parasitic connection with stem of Common Clover. Sec. 2, Animal Histology, Treats of the Ovary and Mammary Glands in Mammalia, and the Ovary and Ova in Birds, illustrated by slides and drawings of Uterus of Rabbit, Mammary Glands of Cat, and Ovary of Bird. Sec. 3, Pathological Histology, treats of Congestion of Kidney and Fatty Degeneration of that organ, the slides and plates illustrating the same being Fatty Degeneration of Kidney, Parenchymatous nephritis, and Fibrosis of Kidney. Sec. 4, Popular Microscopical Studies, in which the chapter on Sea Fans is concluded, Red Seaweeds are described, and an article on Microbes. These are accompanied by slides and plates of tranverse section of Root of Dock; transverse section Fibro-Vascular Bundle of Maize and Microbes. All the slides are of their usual excellence.

The Handy Natural History. By J. G. Wood. With 226 Illustrations. Foolscap 4to, xvi.—367. (London: The Religious Tract Society. 1886.) Price 8s.

Like all the rest of the Rev. J. G. Wood's works, the book before us is exceedingly interesting. It treats of the Quadrumana, Cheiroptera, Carnivora of the Land and of the Water, Ungulata, and Non-Ruminant Hoofed Animals, Rodents, Edentates, Marsupials, Birds, and Reptiles. The whole work is beautifully got up, and the illustrations are excellent.

An Elementary Course in Practical Zoology. By Buel P. Colton. Crown 8vo, pp. xvi.—185. (Boston, U.S.A.: D. C. Heath & Co. 1886.)

This is an admirable class-book, the general plan of study recommended being 1.—The collecting and preserving the specimens, for which very plain directions are given. 2.—The live animal is studied. 3.—The external features

are noted. 4.—The animal is dissected. 5.—The development of a few forms is traced. 6.—After studying each animal, its relations to other animals are considered. Thirty-two insects and other animals are studied, all of which, with perhaps one exception, may be obtained here.

———

First Book of Zoology. By Edward S. Morse, Ph. D. Crown 8vo, pp. xiv.—190. (New York: D. Appleton & Co. 1885.)

Those who wish to gain a general knowledge of the structure, habits, modes of growth, and other leading features concerning the common animals by which we are surrounded, more especially the lower animals, will find great assistance in the study of this book. The outline illustrations of insects and parts of insects are very excellent.

———

British Stalk-eyed Crustacea and Spiders, with an account of their Structure, Classification, and Habitats. By F. A. A. Skuse. Post 8vo, pp. 128. (London: Swan Sonnenschein & Co. 1887.) Price 1s.

We are glad to welcome another admirable little book of the *Young Collector* series. The author first describes the Paraphernalia required by Collectors of both Crustacea and Spiders; next we have a chapter on the Development of these two classes of Animals; next their Habitats and Habits, Classification, Collecting, Uses; and last the Cabinet. The illustrations are numerous and good.

———

Entertainments in Chemistry: Easy Lessons and Directions for Safe Experiments. By Harry W. Tyler, S.B. Post 8vo, pp. 79. (Chicago: The Interstate Pub. Co.)

This book is written for young people, its aim being to show them what Chemistry is, and how to study it. Amongst the subjects treated of are:—The Gases which form the Air, the Chemistry of a Candle, a Glass of Water, etc. A great deal of information may be gained by thoughtfully reading this book.

———

Electricity and Its Uses. By J. Munro. With numerous engravings. Second edition, revised and enlarged. Post 8vo, pp. xv.—200. (London: Religious Tract Society. 1887.) Price 3s. 6d.)

We find here, in a readable and popular form, much information about Electricity, Batteries, the Telegraph, the Telephone, and the Microphone, and a great variety of other matters relating thereto. The edition before us has been enlarged so as to include an account of many recent improvements and new applications of electricity.

———

Rules of Perspective: Explained, Illustrated, and adapted to Practical use. By M. M. Runciman. With letter of approval from John Ruskin, Esq., M.A., etc. Also remarks on Linear Drawing, adapted from the French of J. T. Trebault.

A Manual of Flower Painting in Oils from Nature, with instructions for Preliminary Practice. By W. J. Muckley. Fifth edition.

A Short Study in Gothic Architecture, with Illustrations. By S. T. H. Parkes. Second Edition.

A Manual of Fruit and Still-Life Painting in Oil and Water-colours, from Nature. By W. J. Muckley. Second Edition.

The Art of Pen-and-Ink Drawing, commonly called Etching. By H. R. Robertson. Second Edition.

Trees and How to Draw them, with Illustrations. By Philip H. Delamotte.

THE RUDIMENTS OF DECORATIVE PAINTING (as applied to the Rooms of a Dwelling-house). By Owen W. Davis. (London: Winsor and Newton.) Price 1s. each.

These form a valuable Series of little Hand-books for the Art Student, embracing almost every department of art. They are well illustrated, many of them with coloured plates. We notice that the series now consists of at least 42 Nos., all uniformly bound in stiff yellow paper covers.

THE LEISURE HOUR Volume for 1886. pp. 860. (London Office, 56 Paternoster Row.) Price 7s.

This well-known Magazine offers a large amount and a great variety of most interesting and instructive reading, comprising Tales and Sketches, Natural History Notes and Anecdotes, Notes on Current Science, etc.

We know of no book containing so large a selection of reading more suitable for the leisure hour.

OUR EARTH AND ITS STORY. Edited by Dr. Robert Brown. (London: Cassell & Co. 1887.) Price 7d. monthly.

Parts I. and II. of this new Magazine are to hand. In them is commenced an account of the Physical and Geological History of the Earth, Chapter I. dealing with Land and Water, their Proportions and Relations; Chapter II., The Earth's Crust, its Composition and Formation. Each part contains a beautifully coloured plate, and a number of full-page and smaller engravings. A large Presentation Plate is given with Part I.

SONNETS ON NATURE AND SCIENCE. By S. Jefferson, F.R.A.S., etc. Square 16mo, pp. 96. (London: T. Fisher Unwin. 1886.) Price 2s. 6d.

This little book contains on each page a sonnet on some subject relating to Nature or Science. Many of them are very readable and pretty.

THE ANIMAL WORLD, an Advocate of Humanity. Vol. XVII. pp. 188.

BAND OF MERCY. Vol. VIII., pp. 96.

(London: S. W. Partridge & Co. 1886.)

Two very excellent magazines, issued by the Royal Society for the Prevention of Cruelty to Animals. The first, as its name implies, is devoted almost exclusively to Animals and Anecdotes, etc., respecting them.

We might say pretty much the same of the *Band of Mercy*, but should add that it is addressed to little children. Both are calculated to do a large amount of good in inculcating on young people habits of kindness to animals.

THE PATRIARCHAL TIMES. By Rev. Thomas Whitelaw, D.D. Crown 8vo, pp. 309. (London: James Nisbet & Co. 1887.) Price 6s.

This is a book worthy of careful study. It treats of the Creation of the World; The Appearing of Man; The Cradle of the Race; The First Age of History; The Judgment of the Flood; The Second Age of History; The Table of Nations; The Tower of Babel; The Call and the Pilgrimage of Abraham. It treats all the subjects very thoroughly, arguing both from the Inspired Writings and from Modern Science.

THE TEMPLE OF SOLOMON. By Thomas Newberry, Editor of the Englishman's Bible. Post 8vo, pp. 60. (London: James Nisbet & Co. 1887.) Price 1s.

This interesting little book contains Notes of Addresses delivered at the Victoria Hall, Weston-super-Mare, and describes in very understandable

language—1.—The Temple Courts. 2.—The Temple of Solomon. 3.—The Materials of the Temple. 4.—The Altar of Burnt-Offering.

YOUNG PLANTS AND POLISHED CORNERS; or, Nature in the Light of the Bible. By Charles Hewitson Nash, M.A. Post 8vo, pp. x.—220. (London: James Nisbet & Co. 1887.) Price 3s. 6d.

This little book is addressed to our boys and girls, and in an interesting manner the author first studies with them the beauties of Nature, and afterwards draws such lessons from the study as to carry their thoughts to higher things. All young people and those who have the care and instruction of the young would do well to read this book.

FORBIDDEN FRUIT, for Young Men. By Major Seton Churchill. Pp. xii.—269. (London: Nisbet & Co. 1887.) Price 2s. 6d.

This excellent little work is intended chiefly for the use of young men as a warning against physical and social evils. It is written in such a robust, manly, and yet careful manner, that we heartily commend its perusal, feeling that it cannot but be helpful to all.

DISEASE AND SIN: a New Text-book for Medical and Divinity Students. By a Medical Muser. Crown 8vo, pp. xii.—300. (London: Wyman & Sons. 1886.)

The author, in his preface, states that this work is intended for the use of Medical and Divinity Students.

With a vigorous pen he attacks the morbid, unhealthy sentimentalism of some religious professors and socialists, and if his suggestions were adopted *in toto*, we should certainly have a revolution in modern society.

THE BIBLICAL ILLUSTRATOR. By Rev. Joseph S. Exell, M.A. No. 3. Price 7d. monthly. (London: James Nisbet & Co. 1887.)

Sunday School Teachers and others similarly engaged, will find the Biblical Instructor very helpful. It consists of Anecdotes, Similes, Emblems, Illustration, Expository, Scientific, Geographical, Historical, and Homiletic, gathered for a wide range of Foreign Literature, on the verses of the Bible.

The part before us embraces from the 15th verse of 7th chapter of Matthew to the 37th verse of the 10th chapter.

THE MAN OF SCIENCE THE MAN OF GOD: Leaves from the Life of Sir James G. Simpson. By Rev. Charles Bullock, B.D. Crown 8vo, pp. 90. (London: "Home Words" Office.)

We have derived mnch pleasure from reading this book. Sir James Simpson, the Inventor of Anæsthetics in Surgery, was undoubtedly all that he is said to be in the title of this book.

VESTIGES OF THE NATURAL HISTORY OF CREATION. With an Introduction, by Henry Morley. Post 8vo, pp. 286. (London: George Routledge & Sons. 1887.)

A volume of Morley's Universal Library, and is a cheap edition, unabridged but without illustration, of this well-known and famous work, by the late Robert Chambers.

HEROES OF SCIENCE: Physicists. By William Garnett, M.A., D.C.L. Post 8vo, pp. vii.—332. (London: Society for Promoting Christian Knowledge.) Price 4s.

Much important and interesting biographical information is given us in these pages of some of those men who have distinguished themselves in the world of physical science.

Those whose biographies are here given, are Robert Boyle, Benjamin Franklin, Henry Cavendish, Count Rumford, Thomas Young, Michael Faraday, and James Clerk Maxwell.

THE ROAD TO THE NORTH POLE. First and Second Series. Post 8vo, pp. 128—127. (London: The Religious Tract Society.) 2 Vols. Price 1s. each.

Two interesting books of True Adventures for young people. Vol. I. tells of the Expeditions of Captain Charles Francis Hall, on the *George Henry* and *Polaris*. Vol. II. narrates the American Expedition in the Arctic steamer, *Jeannette*.

MATHEMATICAL TEACHING and its Modern Methods. By Truman Henry Safford, Ph. D. Post 8vo, pp. 47. (Boston, U.S.A.: D. C. Heath & Co. 1887.)

Another of the useful little Monographs on Education, and, like its predecessors, will be found to be fully up to the mark.

THE JOURNAL OF EDUCATION: a Monthly Record and Review. 4to, pp. 524. (London: The Office, 86 Fleet Street.) Price 6d. monthly.

We have before us the Vol. for 1886, and believe that it deals most thoroughly with the subject of Education in all its branches. Its contributors are chiefly gentlemen who are practically engaged in education in public and private schools; the articles are carefully written, and to the point. We notice, also, that monthly prizes are given for translations from French, German, and Latin, and for a small fee unsuccessful competitors may have translations corrected and returned.

HOUSEHOLD HEALTH. By Benjamin Ward Richardson, M.D., F.R.S. Post 8vo, pp. 192. (London: Society for Promoting Christian Knowledge. 1886.) Price 1s.

This is one of "The People's Library," and is a sequel to *The Guild of Good Life*, reviewed by us some time ago. It is written for the people, and is deserving of a place in every home, as it tells us how to keep them healthy.

THE VOLCANO UNDER THE CITY. By a Volunteer-Special. Post 8vo, pp. 350. (New York: Fords, Howard, and Hulbert. 1887.) Price $1.

Describes a great riot which occurred in New York, in 1863, and lasted for four days, and in which more than fourteen hundred men were killed. The author, being a Volunteer-special for the occasion, was an eye-witness of much of the sad work, and writes in a great measure from his own personal knowledge.

HUMOROUS GEMS from American Literature. Edited by G. Edward A. Mason. Post 8vo, pp. 384. (London: Geo. Routledge & Sons. 1887.) Price 3s. 6d.

A selection of some of the best of the humorous writings of American authors, amongst which we notice Irving, Longfellow, Holmes, Beecher Stowe, Ward Beecher, Shaw Lowell, Browne (Artemus Ward), and many others. The selections are well made.

HEADS AND FACES, and How to Study them. By Nelson Sizer and H. S. Drayton, A.M., M.D. 8vo, pp. 199. (New York: Fowler, Wells, & Co. 1886.)

This is a Manual of Phrenology and Physiognomy for the People, Mr. Sizer being President of the American Institute of Phrenology; Dr. Drayton, Editor of the *Phrenological Journal*. It contains 245 illustrations. Those who would learn how to study the characters of their friends should read this book.

THE JOURNAL OF MICROSCOPY

AND

NATURAL SCIENCE:

THE JOURNAL OF

THE POSTAL MICROSCOPICAL SOCIETY.

JULY, 1887.

Dimorphism in Fungi.

By George Norman, M.R.C.S., F.R.M.S., etc.

Plates 15, 16, 17.

I PROPOSE under this head to treat whatever may be further included under the terms Polymorphism, Pleomorphism, and Heterœcism. The subject is one of very great interest owing to the effect that is being produced by this systematic study of the life histories of Fungi on the old lines of classification. Many genera and families are now seen to have no independent position, but to be simply stages in the growth of some other fungus, and a thoroughly fresh classification is thus needed—and is in fact being already attempted—amongst nearly all classes of Fungi except the *Hymenomycetes*. The subject is also one of very great difficulty owing to the minuteness and fragility of the parts to be observed, the great resemblances between certain parts of the

structure in different specimens, especially the mycelium, and the frequent sources of error that arise in the course of experiments from the universal dispersion of spores of all kinds in the atmosphere, and from the undoubted hereditary fungoid infection in many plants.

For the sake of clearness, we can divide our subject into two groups :—

1.—That in which two or more forms occur consecutively or simultaneously on the same individual.

2.—That in which two or more forms appear on a different mycelium, on a different part of the same plant, or on a matrix wholly distinct and different.

The examples to be brought forward are simply illustrative and suggestive. It would be impossible, within the limits of an ordinary paper, to deal exhaustively with the subject.

Taking, then, the first and simplest division, we have a common example in the well-known mould, *Aspergillus glaucus*, a specimen of which would be furnished from almost any housekeeper's jam-cupboard.

From the superficial threads of the mycelium arises a straight tube, which swells at the end, and becomes covered with numerous protuberances. Each of these protuberances becomes constricted just below its termination, and gives rise to a small cell filled with protoplasm. After a time a second cell is produced in the same manner, which pushes the first before it, and so on until a chain of spores is formed, those at the end being the oldest. These are the conidia, which drop off as they become ripe, and are capable of reproducing their kind.

But from this same mycelium, when it gets older, very small branches are thrown out, which terminate in a spiral manner. These small terminal spirals enlarge laterally, and a complicated change takes place, resulting in the formation of a globose receptacle of thin, delicate cells, containing a closely-entwined mass of cells. The whole mass enlarges in size. The outer wall becomes compact and of a yellow colour, and the contained mass of cells becomes converted into a mass of spore-cases or asci, each of which contains eight spores. When ripe, the walls of the conceptacle become brittle and give way, and the spores are liberated.

This fungus is called *Eurotium herbariorum*, and was long considered to be quite distinct, and indeed a very different species from *Aspergillus glaucus*. Now, *Aspergillus glaucus* is considered to be simply the conidial form of *Eurotium*.

Another very good example is to be found in the Grass Mildew. If rankly-growing grass in a damp position be examined during the summer, it will very frequently be found covered with white mildew. If this be examined under a power of 400 diameters, it will be seen to consist of the usual mycelium, from which spring large numbers of conidial chains, similar to those already described, and so delicate that the slightest breath destroys their attachment. This was long known under the name of *Oidium moniloides*, one of the *Mucedines*.

But in the autumn this same mycelium produces a little brown conceptacle, just visible to the naked eye, which, when examined with a low power of 100 diameters, is found to be surrounded with radiating branches, and the interior is also found to contain asci full of spores. This is the fungus known as *Erysiphe graminis*, and although formerly these two fungi were considered quite distinct, they are now known to be simply the conidial and perfect stages of the same fungus. These brown receptacles do not set free their spores during the autumn in which they have been formed, but they fall to the ground with the decaying grasses and rest on the ground all the winter, the hard, outer coat effectually protecting the asci and spores. No sign of life can be detected till the early summer, when these bodies burst and the spores fly out into the air and are wafted in every direction, sometimes absolutely throwing out spawn-threads as they sail about in the air. Those that alight on *Graminæ*, or grasses, attach themselves by their spawn-threads, and immediately produce the *Oidium* over again on their hosts.

A third form of fructification has been described, viz.—pycnidia, which are simply small conceptacles, containing spores, after the nature of conidia. These are sometimes called stylospores.

Another Oidium—which is only the conidial form of another fungus—is *O. leucoconium*, found on rose-bushes. The whole of the leaves of the bush are sometimes grey and shrivelled, from the

abundance of the mould. The perfect form, *Sphærotheca pannosa*, has a very small conceptacle, containing only one spore-case, and is surrounded by simple threads.

Two very destructive mildews—viz., that attacking the vine and that attacking the hop—also belong to this group. In the case of the vine disease, the conidial form alone is known, under the name of *Oidium Tuckeri*. The *Erysiphe* form has not yet been found. In the case of the hop disease, the perfect form is *Sphærotheca Castagnei*. The conceptacle here is small, and contains only one sporangium, or spore-case, and is furnished with only simple appendages. It will be remembered that in my various papers on "Saprolegnia,"* "Peronospora,"† and "Cystopus,"‡ I described in each case a conidial form and a perfect form or oospore.

Another interesting example is to be found in *Hypomyces*, a genus of the order *Sphæriacei*, generally parasitic on the larger fungi. The *Hypomyces*, in its conidial stages, first attacks the host-fungus—say, a *Boletus*. Its mycelium runs through the *Boletus*, reducing the whole fungus to a mass of golden powder, which falls to pieces on the gentlest touch, thus preparing the pabulum necessary for the nourishment and perfection of the higher ascigerous form, which is found in a stroma developed in the ground. This generally consists of a bright-coloured perithecium, enclosing numerous octosporous asci of an elongated form. The conidia—or, as they are sometimes called, micro-conidia—have often been described as autonomous species of *Mucedines*, such as *Botrytis*, *Dactylium*, etc. Besides the micro-conidia, a further form of fructification is sometimes found called macro-conidia, which are large spores, having a thick echinulate coat, of a bright colour. These have also been reckoned as separate species, especially under the name of *Lepidonium*, allied to the *Mucedines*.

Another well-known example is that of *Tubercularia vulgaris* and *Nectria Cinnabarina*, described formerly as separate fungi, but now known to be the same, *Tubercularia* being the conidial form, *Nectria* the perfect ascigerous form. The two forms may be

* See this Journal, Vol. II., p. 185.
† ,, ,, Vol. III., p. 186, 197.
‡ ,, ,, Vol. IV., p. 135.

frequently found growing together on the same stem, and the *Nectria* may often be seen surrounding the *Tubercularia* and arising from the same mycelium, which runs in and under the bark. The *Tubercularia* is a little pink body, and by removing the bark it will be seen to have a paler stem, which spreads above into a globose head, covered with a delicate mealy bloom. A section of this body shows that it consists of delicate parallel threads, compacted together to form the stem and head. Some of the threads are simple and others branched, and they bear here and there little cylindrical bodies, easily detached, and forming the mealy bloom before referred to. These are the conidia.

The *Nectria* is of a darker red colour, and in section is found to consist of a capsule, granular externally, and containing a gelatinous mass, in which are embedded the small masses of fructification, consisting of cylindrical asci or spore-cases, each enclosing eight elliptical spores, and slender threads called paraphyses, which may be abortive spore-cases, all packed tightly together. Examples might be multiplied amongst the *Sphæriacei*, it being a common thing for the conidia to possess the characteristics of a mould, whilst the perithecia, or perfect ascigerous forms, are developed amongst the conidial threads. This applies to species of *Sporotrichum*, *Cladotrichum*, and *Helminthosporium*, amongst the moulds; in fact, it is possible that all of them may in time be found to be simply the conidial forms of some ascomycetous fungi. In one genus, *Melanconis*, three, and sometimes four, sorts of fruit are described. Thus, *M. lanciformis* possesses Conidia formerly known as *Coryenum disciforme;* Stylospores, formerly known as *Coniothecium betulinum;* Pycnidia, formerly known as *Hendersonia polycystis*, and Ascophores, formerly known as *Sphæria lanciformis.*

Amongst the *Discomycetes* there is a good example of dimorphism, in the case of the beautiful purple cups of *Bulgaria sarcoides*, the perfect form, and the small purple clavate bodies found much earlier in the same spot, and also occasionally at the same time as the other, *Tremella sarcoides*, which represents the conidial form of the same fungus. There is a similar sort of relation in form and development between *Dacrymyces* and *Peziza fusaroides.*

Amongst the *Uromyces*, three forms of development are now recognised, showing that *Æcidium*, *Uredo*, and *Uromyces* are but conditions or stages of the same fungus, viz.: 1—Hymenium, or *Æcidium*; 2—Stylospores, or *Uredo*; 3—Teleutospores, or *Uromyces*. This leads us to the consideration of a most important subject, viz.—the Rusts and Mildews of Wheat. These are of two kinds, according to time of appearance, viz.—Spring Rust and Mildew, and Summer Rust and Mildew. The rust is termed *Uredo* and the mildew *Puccinia*.

Spring Rust and Mildew.

The Spring Rust, *Uredo rubigo-vera*, appears on grasses and cereals in March and April in the form of very minute, livid, yellow pustules. When examined with a power of twenty-five diameters, it is evident that the fungus within the leaf of the wheat has, in reaching maturity, burst the epidermis, and appears as a fine orange-coloured powder carried away by the slightest breath of air. A section through one of these pustules, magnified 200 diameters, shows a mass of yellow ovoid spores filled with dense protoplasm and supported on short stalks springing from the mycelium. These spores escape in inconceivable numbers and fall on to the leaves, where they germinate, protruding a spawn-thread from both sides, into which the vital material pours from the spore. As the spore gets empty, a septum appears and cuts off the connection; the germ-tube now enters the stomata of the leaf, and there forms fresh mycelium, from which new *Uredo* pustules arise, and so on until the whole plant is permeated by the spawn.

As the autumn approaches, the yellow *Uredo* spots vanish, and black spots, similar in shape, appear, which are pustules of the mature fungus, *Puccinia rubigo-vera*. The superficial resemblance seems complete except as to colour, but a section through a pustule, magnified 200 diameters, shows a great difference. The spores are blackish-brown in colour and are compound—*i.e.*, they have a joint, or septum, across the narrowest diameter, and besides the spores there are numerous dark, elongated bodies, said to be paraphyses (perhaps undeveloped spores). These compound spores act as resting spores, for although developed in the autumn

they do not germinate till the following spring, when they burst amongst old decaying grass or straw, and both segments will probably throw out transparent threads of mycelium (sometimes called pro-mycelium). As these pro-mycelial threads increase in length, the protoplasm pours from the spore into the tubes, and a series of septa appear, enclosing the protoplasm in the growing end of the tube. From this end two or three minute, transparent yellow spores arise, termed pro-mycelium spores, which speedily fall from their slender supports and germinate readily on damp surfaces.

Summer Rust and Mildew.

This is still more destructive than the spring species, farmers sometimes losing 75 per cent. of their whole crop from its ravages. This Rust is called *Uredo linearis*, and makes its appearance in June and July. It is of a darker orange colour than the Spring Rust, and is larger and more robust in growth, and thus splits and lacerates the cuticle of the affected plant more completely, otherwise the general description is the same. A section through one of the pustules, magnified 200 diameters, shows the great difference in the size of the pustules, and also that the *Uredo* spores themselves, besides differing in colour, differ also in shape from the Spring Rust. They resemble it, however, in the ease with which they are detached from their stems. The germinating process is much the same as in the Spring *Uredo*. The germ tube follows the minute depressions formed where the constituent cells of the epidermis meet, and by following these it ultimately arrives at one of the stomata, which it enters, and branches right and left, ramifying among the green constituent cells of the leaf. Fresh crops of *Uredo* spores are everywhere produced till the whole plant is permeated by the mycelium. As the summer advances, the rust mycelium gradually ceases to produce rust spores, and instead produces the blackish-brown *Puccinia*, or resting spores.

Puccinia graminis.—The pustules of *P. graminis* are much larger than those of *P. rubigo-vera*. A section magnified 200 diameters shows a difference in the shape of the spores, which are mounted on larger stems, in the absence of paraphyses. These spores follow precisely the same course as those of *P. rubigo-vera*. They may be found germinating upon straw as it rots on the

ground in the spring. The pro-mycelium, as it is called, gives rise to the pro-mycelium spores, which are carried about the air in millions. We have thus again the three processes:—the *Uredo*, or rust-spores; the *Puccinia*, or black mildew spores; and the spring, or pro-mycelium spores. Some botanists hold that the process is now completed, and that the pro-mycelium spores just reproduce the *Uredo* spore again. Others hold that the cycle of the corn-mildew is not complete with the production of these spores, but that these spores pass on to another host—the barberry—and there produce an æcidial form, which in turn gives rise to the *Uredo* spore.

We now, therefore, pass from the first to the second division of our subject, where the various forms appear on a wholly distinct and different matrix; in fact, heterœcism, pure and simple. Heterœcism is accepted as a fact by, I believe, all continental botanists, and by many also in this country. It is still, however, rejected as unproven in this case by such mycologists as Dr. M. C. Cooke and Mr. Worthington Smith. As Mr. Plowright is the chief investigator on the subject in this country, I shall quote his observations first. Living in a district where the wheat-mildew was very fatal to the crops, and where the theory of the barberry blight being connected with it was very prevalent amongst agriculturists, he determined to investigate the matter by experiment—viz., by infecting a number of wheat-plants with ripe spores of the barberry fungus. The result was that while 76 per cent. of the infected plants took the disease, no less than 70 per cent. of similar wheat-plants, kept as check plants, became spontaneously affected with mildew. In consequence, he wrote in *Grevillea*, December, 1881, that he felt bound to differ from the eminent botanists abroad, who accepted the heterœcism of *P. graminis* as an established fact. In the spring of 1882 he commenced a fresh series of experiments with a great deal more care than he had used the first time, but having, as he says, a mind biassed against the theory of heterœcism. This time, not only was barberry fungus sown upon wheat under circumstances which should, as far as possible, preclude the agency of accidental infection, but, conversely, the wheat-mildew was sown upon barberry plants. All the wheat plants were kept continuously covered by bell-glasses from

the time they were sown until the experiment was concluded. All those infected with barberry fungus gave rise to the *Uredo*, whilst none of the check plants developed the disease. Of half-a-dozen small barberry plants three were infected with the pro-mycelium spores of *Puccinia graminis* from wheat, the other three being kept as check plants. The three infected plants produced *Æcidium;* the three control plants remained perfectly free from *Æcidium.* Besides the cluster cups there exists in company with the *Æcidium* another set of organs developed from the same mycelium, called spermogonia. They are small, flask-shaped bodies, sunk in the substance of the leaf, on the opposite side of the leaf to the *Æcidium*, and they are filled with delicate threads, which bear upon their ends chains of minute bodies called spermatia. There is little doubt that they play the part of the male element, and are the small bodies constantly seen surrounding and adhering to the spores of *Æcidium.*

According to this view, then, we have no less than five kinds of reproductive forms in connection with this fungus, viz.—Æcidium, Spermogonia, Uredo, Puccinia, and Pro-mycelium. It should also be said that while *Æcidium berberidis* is supposed to be the *Æcidium* in connection with the summer mildew, *P. graminis; Æcidium asperifolii*, an *Æcidium* belonging to the Borage family, is supposed to be the form connected with the spring mildew, *P. rubigo-vera.* Mr. Worthington Smith objects to these conclusions on the following grounds:—That corn is so seldom free from red rust, and barberry bushes so seldom free from barberry blight, that there is never any certainty that both corn and barberry bush do not possess traces of the disease before the experiments are commenced. And that as pro-mycelium, pro-mycelium spores, and sporidioles are potential, both in *Puccinia* and *Æcidium* alike, it is unlikely that there is any genetic connection between these fungi. He traverses an argument from analogy, advanced by some believers in heterœcism, viz.—the change of host in certain entozoa, which is too long for us to enter into in these pages. He complains that Mr. Plowright has not given an illustration of his own of the germ-tube of the pro-mycelium spore piercing the epidermal cells of a barberry leaf, and as to the *Æcidium* of the Spring Rust, *Æcidium asperifolii*, he

says it is so rare that he has never met with it. The advocates of heterœcism have, however, been claiming fresh discoveries since this controversy, and apparently very distinct fungi, growing on most opposite matrices, are now suggested to be related to one another. Thus, a *Coleosporium* found on *Senecio vulgaris* is supposed to be one stage of *Peridermium Pini*, and so on with many others.

In the *Quarterly Journal of Microscopical Science* for 1885, Mr. Plowright has a further series of observations on the "Life History of Certain British Heterœcismal Uredines," in which he details the results of three years' experiments. Many of these experiments are simply repetitions of what have already been tried on the continent, which he undertook for the purpose of verification, but some are quite new. The Ranunculus family are peculiarly liable to be affected with *Æcidium*, no less than eleven species having *Æcidia* more or less frequently upon them, while only four have *Uromyces*, or Uredospores, affecting them. It is shown that in one case—viz., the *Æcidium* on *Ranunculus ficaria*—the connection is not with the Uromyces occurring in this same plant, but with one affecting the various *Poæ*, especially *P. trivialis* and *P. pratensis*. This same *Æcidium* is also found affecting *R. repens*, and also produces its Uromyces in *P. trivialis* and *P. pratensis*. But in this same *R. repens* occurs another *Æcidium*, very much like the former, but which is connected with quite a different fungus—viz., *Puccinia magnusiana*—the Uredospores of which are found on the common reed, *Phragmitis communis*. In 1883, Mr. Plowright found a long, straight ditch, full of reeds, which for about twenty yards at both ends were completely blackened by *P. magnusiana*, those in the middle being quite free. In the spring of 1884, he, from time to time, carefully examined the *Rumices* and *Ranunculi* growing on both banks, feeling quite sure he should find the *Æcidium* at both ends, but not in the central part, and eventually he proved right, for at both ends of the ditch he found *R. repens* abundantly affected with *Æcidia*, while in the centre they were quite free. The *Rumices* remained free altogether. He had previously experimented with the spores of these fungi, and so been led to the surmise, which was thus proved correct.

Another *Puccinia*, *P. phragmitis*, also abundant on the common reed, had its æcidiospores on various species of *Rumex*. Several others are referred to in the same paper, which I need not enter into. Space prevents entering on any further examples, and one can only refer in passing to the interesting fungus, *Isaria*, growing on grass, etc., and its perfect form of *Cordiceps* and *Torrubia*, one species of which is parasitic on the truffle and another on the pupæ of moths and other insects. But I wish, in conclusion, to refer to the lowest form of fungi, viz.—the *Schizophyta* or *Bacteria*. Professor Ray Lankester, in the April number of the *Quarterly Journal of Microscopical Science* for 1886, has a paper on the Pleomorphism of the *Schizophyta*, the object of which is to show that he had, in a paper published twelve years ago, put forward the view of the subject that is now being generally accepted.

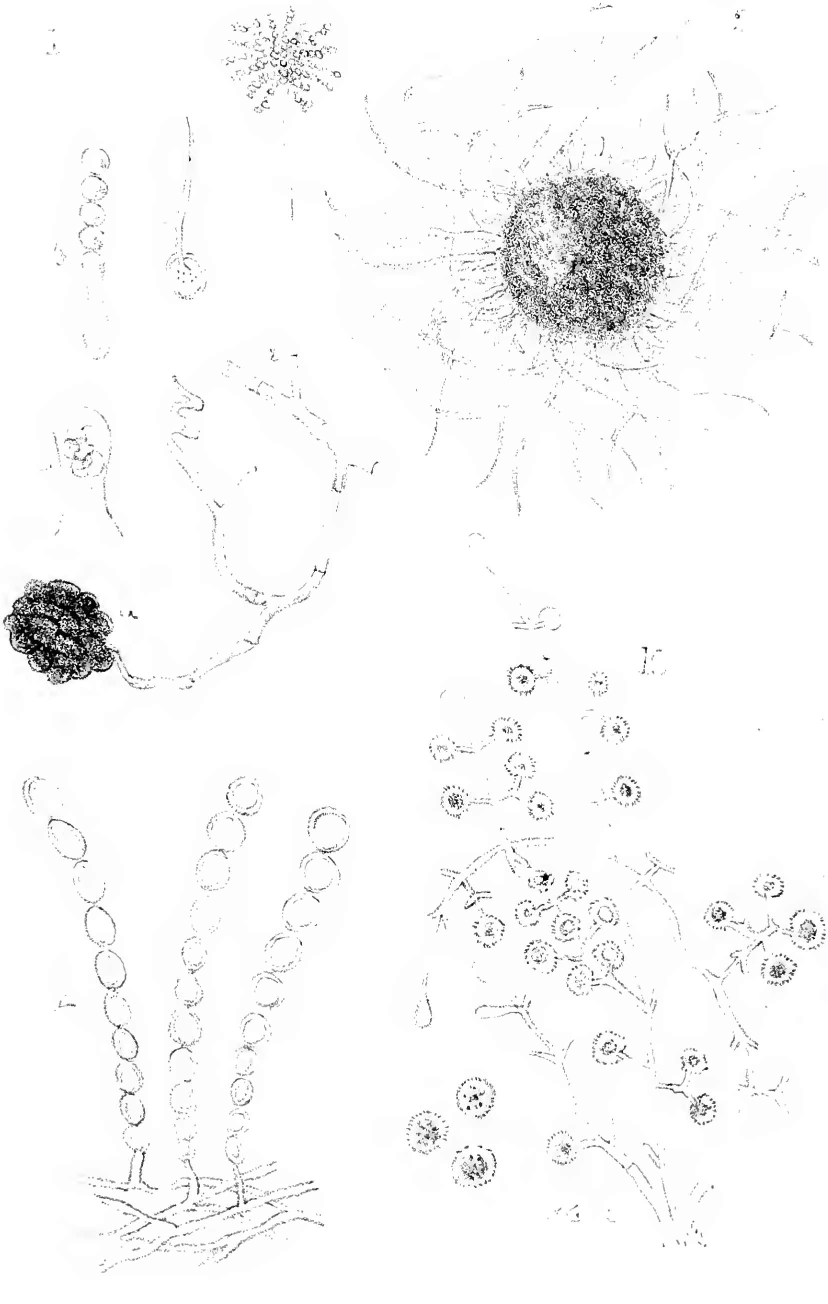
He discovered a peach-coloured bacterium, which exhibited a wide range of forms, connected by intermediate forms, growing together in the same vessel, and linked together most unmistakeably by the fact that they were all coloured by a special pigment. He observed this organism on many occasions, and from various localities he obtained some modifications of form by cultivation, but chiefly depended on the association of the different forms, the presence of completely transitional forms, and the common bond of pigment, for the views as to their nature which he put forward. Cohn had just then put forward the view that *Micrococcus*, *Bacterium*, *Bacillus*, *Vibrio*, *Spirillum*, and *Leptothrix* were different genera. Lankester regarded them as form phases, or variations of growth, of a number of Protean species, each of which might exhibit, according to undetermined conditions, all or some of these forms; and that the existence of true species must be characterised, not by their simple form-features, but by the *ensemble* of their morphological and physiological properties, exhibited in their complete life-histories. He then says that this view, which he put forward in 1873, is precisely that which is espoused by Prof. de Bary in 1884, when he writes, in his work on the comparative morphology of fungi, "Strictly-made morphological and developmental researches are now to hand. They have demonstrated that the forms known as cocci, rods, threads, etc., are phases of

growth." Prof. Lankester concludes by saying, "Some of the recently published books dealing with the cultivation of pathogenic Bacteria contain also a general summary of what is known as to the natural history of the group, and an attempt to classify the non-pathogenic together with the pathogenic species. The importance of the doctrine of the pleomorphism of Bacteria in relation to pathological inquiries cannot be over-estimated."

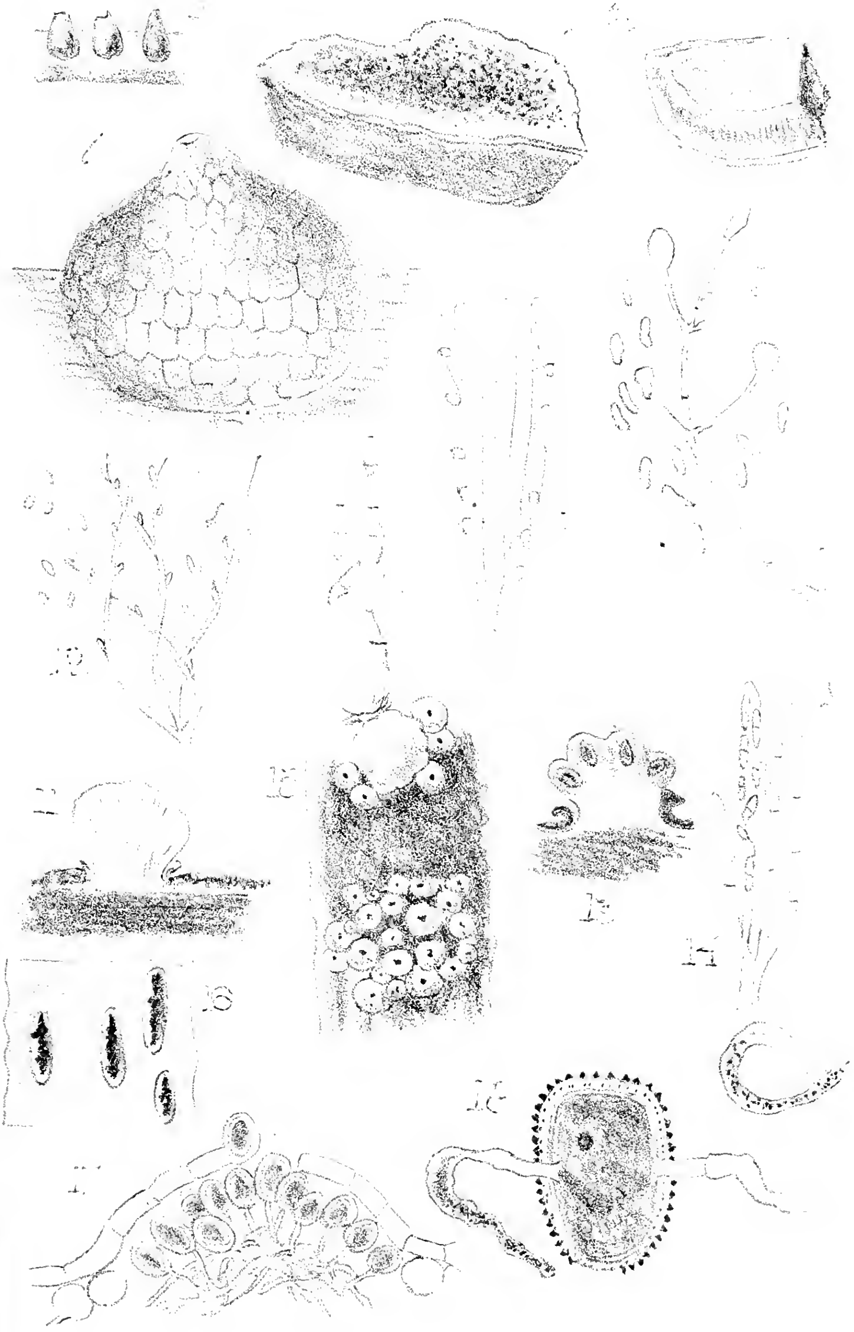
BIBLIOGRAPHY.—*Quart. Journ. Micro. Science*, 1885—86; *Grevillea*, various years; "Fungi" (International Scientific Series); "Diseases of Field and Garden Crops" (Worthington Smith); "Rust, Smut, Mildew, and Blight" (Cooke); *Gardener's Chronicle*, etc.

EXPLANATION OF PLATES XV., XVI., XVII.

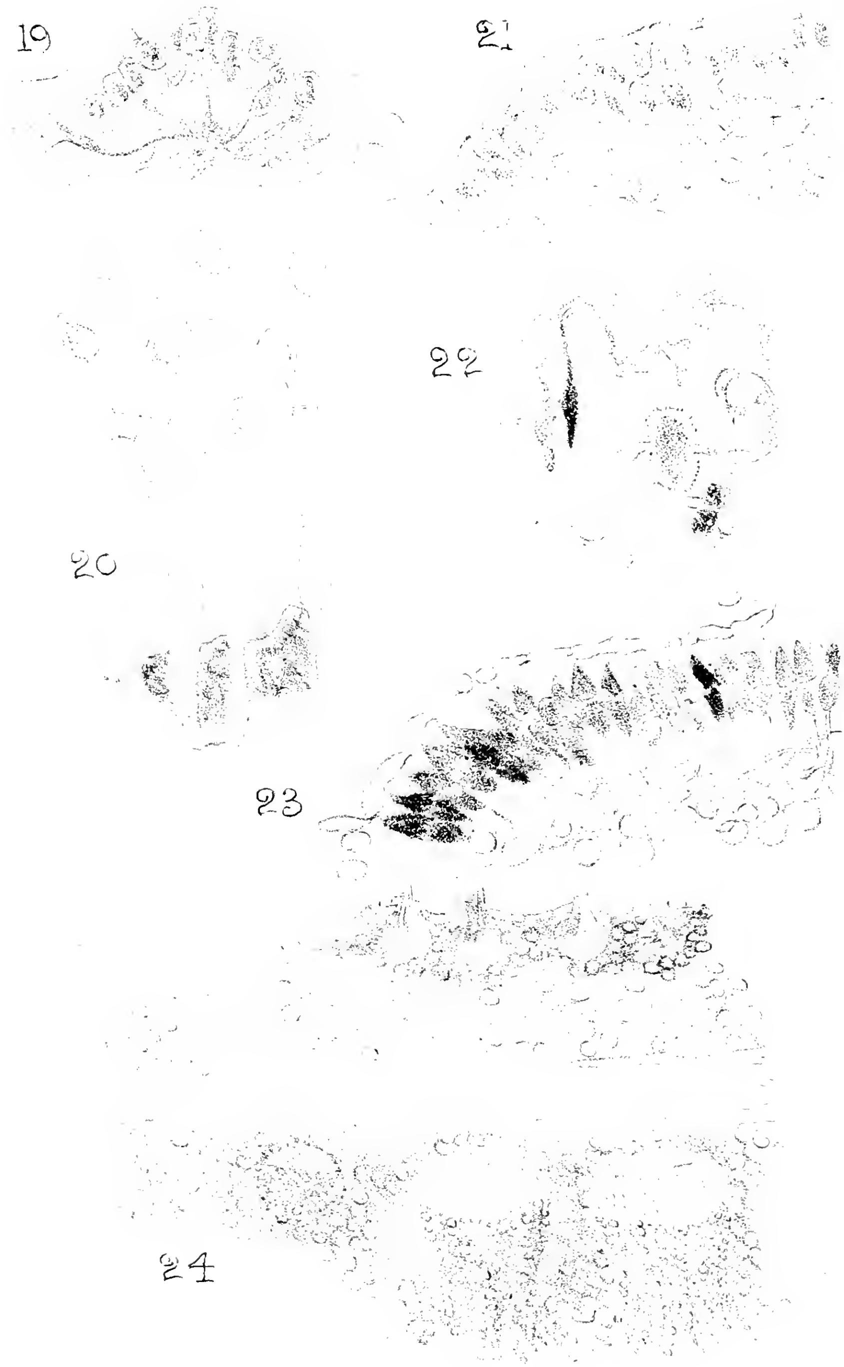
Fig. 1.—*a*, *Aspergillus glaucus*; *b*, conidia; *c*, germinating conidium; *d*, *Eurotium*; *e*, ascus of *Eurotium*.
,, 2.—*Erysiphe graminis*, conidia.
,, 3.—Ditto, conceptacle.
,, 4.—Portions of *Agaricus*, with parasitic Hypomyces.
,, 5.—Conidia.
,, 6, 7.—Conceptacles of Hypomyces, slightly and highly magnified.
,, 8.—Asci.
,, 9.—Spores.
,, 10.—Stylospores.
,, 11.—Section of *Tubercularia vulgaris*.
,, 12.—Conidia.
,, 13.—Section of *Nectria cinnabarinis*.
,, 14.—Asci.
,, 15.—Portion of twig, with *Nectria* and *Tubercularia*, *in situ*.
,, 16.—Wheat-leaf, with pustules of *Uredo rubigo-vera*.
,, 17.—Section of a pustule, showing the Uredo spores.
,, 18.—Germinating Uredo spore.
,, 19.—Section of pustule of *Puccinia rubigo-vera*.
,, 20.—Germinating telento spore.
,, 21.—Section of half a pustule of *Uredo linearis*.
,, 22.—Spores of *Uredo linearis* germinating on a wheat-leaf.
,, 23.—Section of half a pustule of *Puccinia graminis*.
,, 24.—Section of Barberry leaf, showing cups of *Æcidium berberidis* on lower surface, and spermogones on upper surface.



Dimorphism in Fungi



Dimorphism in Fungi



Dimorphism in Fungi.

The Microscope in the Lecture and Class-Room.

By William Pumphrey.

HOW to make the microscope available in the lecture and class-room must often have been the unavailing desire of him who has had to stand behind the lecture-table when some point of insect anatomy had to be elucidated, or when a class had to be instructed in the ultimate details of vegetable physiology. Who has not longed for the ability to place before his audience or his class exactly the point or points he desired to impress upon them, and who has not felt that to do so was almost an impossibility?

So far as the lecture-room is concerned, the microscope in its ordinary form is absolutely useless. There are no means whereby the occupants of the room can be made to see in the microscope, at one and the same time, the object, or the special part of an object, that the lecturer wishes to call their attention to. It is true that at the close of the lecture the audience may be invited to examine preparations illustrative of the lecture. But, then, to make this of much use, the lecturer must be prepared to repeat, to a great extent, what he has already explained, and this to each observer and with every specimen.

With a class of, say, a dozen students, the thing is a little more practicable, but the business is a very onerous one, and its results at best very uncertain. Perhaps, in the course of his one hour's lesson, the teacher has to call special attention to, for example, six preparations. In order that the class may follow the lesson, and fully understand and appreciate the point intended to be enforced by these preparations, it will be needful that each student should have a microscope and be furnished with a preparation, so that he may follow the points of the teacher's lesson. This, of course, involves a dozen microscopes and six dozen preparations. But this is not all. Probably, no two of the students are equal in their powers of observation, and the preparations are certain to be of unequal merit; and supposing that these causes of uncertainty could be removed, the teacher has no proof that

the point which he desires specially to impress on his class has been clearly seen and noted by each member of the class.

But, how would all these difficulties vanish, if it were practicable to throw on the screen enlarged images of the objects of such dimensions as would admit of all seeing them easily and sufficiently distinct to make evident the special point that the lecturer or teacher desired to explain. There would then be no question of the powers of observation of the student, and there would be no difference in the quality of the preparations. All would see the same object, and the teacher would be able to call special attention to the point under discussion, and he would be in no doubt whether or not attention had been directed to the actual or to some supposed detail. It cannot, therefore, be a matter of surprise that many attempts have been made to attain this desirable object, and we now have to consider these attempts, and how they have been successful or otherwise, and what are the difficulties to be overcome.

As all objects, whether micro- or macro-scopic, are visible solely by virtue of the light that they emit, intercept, or reflect, we may in the first place consider what sources of light are available for our purpose. First, in point of efficiency, stands solar light. The rays that issue from a source so distant are practically parallel, and as such easily converted into converging or diverging beams. Then, solar light is more intense than any other (I speak under correction on this point). I find Dr. Young, in his treatise on "The Sun," sets down the brightness of the sun's disc as 190,000 times that of the brightness of a standard candle. This intense brightness of the solar light is a most important consideration, and were it available at all times would leave us little to desire so far as light is concerned. But in this country, at all events, sunlight cannot be calculated on, and is entirely wanting at those times when the lecturer and teacher are most likely to want its help; therefore, for the purposes we are considering, sunlight may be set aside as not available. There is also this objection to sunlight when used in any concentrated form. The heat-rays which accompany it are so numerous that I doubt whether it be possible so far to absorb them as to admit of bringing delicate preparations within their reach.

The next source of light is the electric arc, as formed between electrodes of carbon. This, under good conditions, approaches to a fourth of the brightness of the sun, or about 47,000 times the brightness of a standard candle. Here, then, we have a splendid source of light, and with this great advantage, that the heating rays which accompany it are comparatively few. It is mainly a question of cost and complexity of apparatus. In the present state of electric engineering we should require a gas- or steam-engine to drive a dynamo, and then either take the light direct from the machine, or make use of a secondary battery in which the electric energy can be stored and used as required. If we adopted the former plan, we should be almost sure to have a very variable light; and if the latter, should run the risk of an entire collapse from the escape of the electric fluid. In either case, we must provide machines and apparatus that are necessarily not only very costly, but very cumbersome. The time may come when electric light shall be supplied as gas is now supplied, and then we may hope successfully to use it in our microscopic lanterns. But, at present in Bath, the electric light is not available, though a constant source of light might be secured by utilising the water which runs to waste over the weir at the old city mills.

As a source of light, we next come to the Drummond, or lime-light, but its value is very small as compared with sunlight or electric light. In its most effective form it gives a light equal to about 450 candles, but in general it does not exceed 150 candles. We need hardly mention any of the forms of oil or gas lamps, as few, if any, of them would give us more than a 50-candle power.

It appears, then, that for the present we are confined to the use of the lime-light in its best form—that is, to the use of lime, magnesia, or some other earth rendered incandescent by a jet of oxygen and hydrogen gases, mixed before they issue from the blow-pipe. Next, how can this light be most usefully applied so as to produce on the screen a magnified image of the microscopic preparation? It is impossible to transmit to the screen a greater amount of light than falls on the area within which the object is placed. Let us suppose this to be a circle of half-an-inch in diameter, and the screen that we desire to fill nine feet in diameter. It is

clear that the light which falls on the half-inch circle will be diluted on the screen to 1—46,656th part of the brightness of the light where it met the object, and if, as must be the case in most minute objects, the area of the enclosing circle does not exceed a quarter or a one-eighth of an inch, the light on the screen will not exceed the 1-186,624th or the 1-746,496th part of the original brightness. It is, therefore, needful that the original brightness of the light, as it meets the object, be increased as the magnifying power is increased.

The rays of light that proceed from the incandescent lime are divergent, passing forward in straight lines in every direction, and only such portion of them as we can compel to change their direction are of any use to us. The first thing, therefore, is to convert these diverging rays into a parallel beam of light. This may be effected by means of a concave mirror or a convex lens. For the purpose we have in hand, a lens will be the more convenient. The action of a second lens changes this parallel beam into a convergent beam, and in this convergent beam the object is placed, its position being dependent on its diameter. The final result on the screen will depend to a great extent on the accuracy with which this conversion of the rays is accomplished. The source of light must be concentric with the optical axis of the lenses, and the lenses must be of such a character, both as regards their transmitting and their refracting powers, as to arrest as little light as possible, and conduct it forward with the least possible dispersion. Theoretically, there ought to be no difficulty in bringing the light which issues from the lime into a cone with a very fine apex; but in practice it is very difficult. There is a large amount of light reflected from the various surfaces of the lenses—the light itself is not a simple point—and several other causes contribute to make the cone of rays very imperfect. And yet the adequate illumination of the smaller objects depends almost entirely on the perfection of this cone.

An arrangement should be made whereby the object to be illuminated can be placed in that part of the cone of light which will best cover it. Thus, the more minute the object, the nearer the apex, and *vice-versa*. If the cone were perfect, the screen ought to be equally well lighted under all conditions of amplitude;

but this is not found to be the case. The objects that require least amplification are always shown on the screen brighter than the more minute.

While we are considering that part of the arrangement that concerns the condensation of the light, there is a point which requires attention. The amount of heat produced by the combustion of the hydrogen and emitted from the incandescent lime is so great that when collected by the lenses it would spoil any delicate preparation, unless some means were adopted to absorb these heating rays. This is best effected by interposing a cell with parallel glass sides containing a saturated solution of common alum (potassium and aluminium sulphate) ; but the use of this solution has been claimed as a special point in the patent of Messrs. Wright and Newton, and so not to infringe their patent right we can dispense with the alum and use the water only. This will intercept by far the greater part of the heating rays, and those which do pass will not produce any inconvenience.

The remaining arrangements are those of the ordinary microscope, except that we dispense with the eye-piece, taking our image to the screen direct from the object-glass. We also dispense with the plane or concave mirror, usually placed beneath the stage of the compound microscope. In displaying objects on the screen, the effect is much more pleasing if the margin of the field is well defined. There are considerable difficulties in obtaining this with lenses of high powers. This is because the object to be shown is seldom or never in the same plane as the margin of the diaphragm, and it is this which limits the illumination on the screen. Even when the object is so placed that only the cover-glass interposes between the object and the stage, the thickness of this is sufficient to give a disc with blurred edges. This might, perhaps, be obviated by placing a stop between the object-glass and the screen.

There is another point of great importance as affecting the result, and that is the suppression of all light except that which passes through the object-lens. The lantern should be so constructed as not to allow any light to pass into the room, and all parts where reflectors or refractors are employed should be carefully guarded, and when it is possible the walls and ceiling of the

room should be of a dark colour. Especially is the proximity of a white ceiling to be avoided. Light is reflected from the screen to such a ceiling, and from it again to the screen, and a great loss of effect is produced.

The object should be projected on and not passed through the screen. A good, smooth, plastered wall forms the best screen: calico, faced with smooth, white paper, comes next. If the conditions are such as to make a translucent screen a necessity, tracing-cloth or tracing-paper will be found to act much more satisfactorily than a wetted sheet. In all cases where a translucent screen is used, all spectators that are near the axial line of the light and lenses see a bright spot of light in the centre of this field of view that greatly detracts from the effect.

But when we have done our best and obtained the greatest enlargement and definition at present practicable, what does it amount to? Will it enable the lecturer to place before his audience all that he requires to illustrate his subject? Will it place within the reach of the teacher the power to demonstrate to his whole class, at one and the same time, all the special points that call for particular notice? I am inclined to think that for the lecture-room good photo-micrographs will be found more useful than real objects shown direct on the screen. The lecturer has not often occasion to enter into many of those details of ultimate structure that are so important to the teacher, and a good photo-micrograph, prepared beforehand, and specially arranged to illustrate the precise point of the lecture, will be more effective when produced before a large audience than a real object when shown on the screen. At the same time, the manipulation of the ordinary lantern is much simpler.

To the teacher, I think that the oxy-hydrogen microscope, in its best form, offers more advantages. In the first place, it will not be needful to employ so large a screen, and therefore the light will not be so greatly diffused, and the resulting picture will be brighter. Then the ordinary arrangements of a class admit of the more close examination of the image on the screen, and many details that could not have been seen by a large company would be readily seen by a few students, who could closely examine the image on the screen. Still, I have no doubt that there will be

many points in the ultimate tissues, both of animals and vegetables, that the oxy-hydrogen microscope will fail to display, and for which no substitute for the direct eye of the observer can be provided.

POSTSCRIPT.

At a subsequent meeting of the Society, held at his own house, Mr. Pumphrey conducted a series of experimental demonstrations, showing the advantages to be derived from the exhibition on the screen of magnified images of actual objects, and also pointing out the difficulties attending the process, and where it was most likely to fail. Carefully-prepared micro-photographs were displayed on the screen, along with magnified images taken direct from the same objects; and the opinions advanced in Mr. Pumphrey's paper were endorsed by all present—namely, that when the object was to demonstrate to a class, or to a small company, who can critically examine the image as displayed on the screen, the image, as taken direct from the object, was much to be preferred; but that for large companies, and where the close examination of the image would be impracticable, the micro-photograph was better adapted to the purpose. The subject was also considered with reference to the attainment of the same end by means of carefully-prepared diagrams and black-board illustrations. It was felt that unless there was a probability of the former being frequently used, the requisite expenditure of time and labour was too great for most persons; but as regards the latter the opinion was expressed that the free use of the blackboard, in illustration of the papers read to the Society, was a great advantage.

On the Water in the Chalk beneath the London Clay in the London Basin.*

By Robert B. Hayward, M.A., F.R.S.

MY object in the present paper is not to bring forward any new facts or observations, but the collocation and juxta-

* Read at a meeting of the County of Middlesex Natural History Society.

position of ascertained and published data to suggest certain inferences, which it would seem to require more extended observations to confirm or refute, and still more to propound certain questions to which I, at least, have been unable to obtain satisfactory answers.

The sinking of an Artesian well affords an opportunity of obtaining data of the highest importance at once to the geologist, to the chemist, and to the economist and engineer. Each naturally appropriates and tabulates the facts which have an especial relation to his own particular science or practical object, and ignores those with which he is not directly concerned. Hence we find excellent geological accounts of well-sections without a word as to the quality, composition, etc., of the water obtained from the well; elaborate tables of analyses of water with the barest allusion to the geological structure of the locality of its source, or the copiousness of the supply; or, again, full details of the size and depth of the well, the level at which water was obtained, the height to which it rises in the well, and its general character as to its fitness for domestic purposes, as shown by its greater or less freedom from organic impurity and its greater or less hardness, without any further notice of its special chemical constitution, or any special characteristics of the strata whence it is derived.

Now, I think there could be no more appropriate or useful work for a Committee of our Society, whose sphere of operation extends over a county in which there are probably more Artesian wells than in any other district of the same area on the face of the globe, than to collect together in one focus every possible detail, geological, chemical, economical, and structural, with respect to as many existing wells as possible, and still more to ensure that the same shall in future be obtained and recorded for every new well that is sunk in Middlesex or within the neighbouring parts of the Thames basin. I cannot doubt but that the mere bringing together of the results of specialists in the several sciences working on the same subject-matter and tabulating them in one standard form so as to admit of immediate and accurate comparison between one instance and another, would lead to conclusions of great value, not only to the practical question of the water supply of an ever-growing community, but also to various sciences, and, it may be, to quite unsuspected generalizations.

For it should always be remembered that, when the main broad outlines, and even what at any particular time appear to be minute details, in any subject of science have been worked out, there always remain some residual small quantities or minor facts (as they seem) to be accounted for, behind which possibly lurk some of the grandest secrets of nature. The history of Science is full of instances of this truth.

I would urge therefore that the collection, and registration in convenient forms for comparison, of any facts or observations, however apparently trivial in themselves, is a worthy—perhaps I might say, the most important—service which a society such as our own can render to the progress of Science and the knowledge of Nature.

But leaving these general observations, let me now proceed to my special subject. You will probably pardon me if, in order to make clearly intelligible the question which I have to propound, I summarise some facts as to the geological structure of our county which are doubtless quite well known to many, if not most, of those present at this meeting, only casting them in a mould which is suitable for my purpose. Let us suppose that we are proceeding to sink a well from the spot where we are now assembled (Kilburn). I am not aware whether there are any special peculiarities in the surface soil and upper layers at Kilburn, but if not, I apprehend we shall find beneath a foot or two of surface soil, a stiff brown clay, in which, without much variation, except for an occasional stony layer of a concretionary character from 6in. to 18in. thick (known as Septaria), we should dig for some 220 to 250 feet, and then for a foot or two through a more or less sandy bed, possibly some more clay, and then a bed of well-rounded pebbles. This group of strata is known as the London clay with its basement bed. Throughout no water would enter our shaft, unless possibly a small quantity in the sand of the basement bed. Then for the next 60, or perhaps 80, feet we should pass through a much more variable series of beds, consisting of light-coloured clays, streaked and mottled with various brilliant colours like mottled soap, an occasional layer of lignite coated with iron pyrites, and one or more beds 2 to 4 feet thick of sand, with probably a thicker bed of sand and pebbles lying on the surface of the chalk, which we might

now reach. This series of strata is known as the Woolwich and Reading beds, from the places where they appear close to the surface. From one, if not all of the beds of sand, we should almost certainly find a considerable quantity of water pouring into our shaft, but it is not the water of which we are in search, as, besides being probably deficient in quantity, at any rate, after a short period of pumping, it is doubtful whether its quality would be satisfactory for domestic purposes. Our engineer would, therefore, be careful to exclude it entirely from our well by iron cylinders or other suitable lining. He ought, however, in the interest of science, to take a few good samples of this water to be handed over to a chemist for analysis. (I speak penitentially, having to reproach myself for not having done this when, a few years ago, a new well was sunk at the Harrow Waterworks, having lived to regret the neglected opportunity.)

I said that we might now find that we had reached the chalk, but we might find a certain thickness of other sands to be passed through (as we certainly should farther south), known as "Thanet sands," or "grey sands." It is stated that where the Thanet sands exist below the Reading beds, water is usually found in the lower Thanet sand, and not in the sand of the Reading beds. Also, "that the grey (Thanet) sand contains a highly argillaceous mixture in its lowest part, which serves to isolate it as a water system from that of the chalk" (Lucas). I cannot find distinct evidence as to whether, where the Thanet sand is absent, there is, or is not, separation of the water in the sand above from that in the chalk below by entirely, or almost entirely, impervious clayey beds. Probably there is free communication in some localities, and more or less separation in others.

Our shaft having reached the chalk, we shall probably continue the well by a borehole from its centre, carried into the compact mass of the chalk, until we obtain a copious supply of water, probably from having tapped some fissure filled with water, which, at this depth, will be under considerable pressure. It may probably be found well to carry this borehole to a depth of 100, or even 200 or 250, feet into the chalk. We shall now have obtained a copious supply of excellent water—bright and sparkling, with a small degree of salinity sufficient to make it brisk and pleasant as

a drinking water, absolutely free (unless our well has been badly constructed, so as not to exclude all other waters) from organic impurity, and, unless we are unfortunate in our locality, as I believe here we should not be, having so small an amount of hardness as to be properly classed as a soft water. We may, however, be unfortunate, and find that the water, while it possesses every other merit, is excessively and stubbornly hard, and then woe to the unfortunate water company which has sunk the well and its directors, if the clients whom they supply find their domestic boilers and hot-water services continually furred up, and there is a neighbouring company ready to invade their district with a water which, if not so good in some respects, has not this conspicuous demerit. I speak feelingly as a former director of the Harrow Water Company which is now extinct, having been thus unfortunate and therefore extinguished after the fashion at which I have hinted. It was from our efforts to deal with this stubborn water that I was led to turn my attention to the questions I am now attempting to discuss.

When the well is finished, the water (when pumping is not going on) would probably, at this date, be found to stand in the well just about up to the Ordnance Datum Level, or level of the sea; that is, since the top of the chalk is here about 180 feet below the O.D., it would stand about 180 feet above the top of the chalk, and nearly at the same depth below the surface of the ground. This shows that the spring of water which we have tapped is under a pressure of considerably more than that of a column of water 180 feet high. The quantity of water which would be obtainable for distribution from the well would be rather limited by the power of the pumps than by the capacity of the well—at any rate, up to a million gallons per day, and probably considerably beyond.

If we now enquire whence all this water comes originally, we shall find that, like all other sources of water supply, it is to be traced to the rain which has descended from the clouds, though it has had a long underground journey since it left the light of day. The geological structure of the Thames Basin, of which Middlesex forms a part, is (so far, at least, as we are concerned with it here) very simple. Every one who travels, with his eyes only half

open, must have observed that in journeying along any of the railways which radiate from the metropolis, except only those which go direct to the coast of Essex and Suffolk, he passes through a district of considerable width, in which the rock underlying the surface soil, or even the surface itself, is chalk. A more careful observer will see, by observing the chalk strata, where exposed in cuttings or pits, that they dip gently towards the central line of the valley of the Thames, disappearing beneath clays and sands in the strata immediately above, which, as we proceed from the chalk district towards the Thames, very soon give way to that huge sheet of London clay which forms the surface rock of almost the whole of Middlesex and much of the adjoining counties. This suggests that the chalk everywhere exists beneath this sheet of clay, and in fact forms a basin (or rather *saucer*, a very shallow one), in which the clay lies, a suggestion which is made a certainty by the wells which, like the ideal one we have been considering, have been sunk into the chalk in all parts of the district.

These features are shown accurately to scale in the horizontal section published by the Ordnance Survey, extending for 36 miles from the downs of Beddington northwards through Mitcham, Clapham Common, Battersea Park, across the Thames to Hyde Park Corner, through Regent's Park by the Zoological Gardens to the London and North Western Railway, when it turns to the north-west and passes through Hampstead (showing a section of the hill), Hendon, Elstree, Aldenham, across the Colne, and on over the open chalk to Hemel Hempstead.

Now, let us consider the bearing of these facts of geology on the question of the source of the water in our deep wells.

Since compact clay, such as we find in the widespread sheet of the London clay, is impermeable by water, it is plain that the 150 or 200 feet of thickness of this clay effectually prevents any of the rain that falls on its surface from penetrating to deep wells. The breadth of the water-bearing sands between the London clay and the chalk is small at their outcrop, and consequently the water which enters into and saturates these beds represents only the rainfall and drainage of a comparatively small area. It is very different, however, when we come to the outcrop of the

chalk. It has been estimated by the Rivers' Pollution Commission (6th Report, p. 298), that there are, within 30 miles of London, areas covered by the chalk formations (including in this the upper green sand below the true chalk, which, however, covers a comparatively small area), extending over 635 square miles on the north, and 213 miles on the south of the London clay formation; and within 40 miles of London, 1,298 square miles on the north, and 301 on the south of the same. Of the rain which falls on this very large extent of surface, such part as is not lost by evaporation, or taken up by vegetation, is absorbed by the chalk. Chalk is capable of absorbing about one-tenth to one-eighth of its weight of water, and when thus saturated, any additional water under pressure would slowly pass through it and fill the joints and fissures in the rock. It is a necessary consequence that below a certain level in the Thames basin, at any given time, the chalk is thus saturated, and its fissures filled with water. The height of this level varies with the seasons and the greater or less amount of rainfall, and is determined mainly by the level of the higher springs, which feed the rivers (like the Colne) which run through the chalk district. Below this the chalk must always be saturated, and the only effect of variable rainfall is to slightly increase or diminish the pressure in the water, which is slowly moving through it. Of course if the chalk were everywhere sealed up by clay above it except at its outcrop, the water in it could only escape at the outcrop, and below would remain motionless in its reservoir; but the Thames, in its course both west and east of London, crosses uncovered chalk, whence it receives large supplies of water, while there is probably considerable drainage from the chalk into the Thames estuary and the sea itself to the east. It is plain therefore that, from this natural cause, as well as from the artificial drafts upon it from Artesian wells, there must be a flow of water from the higher to the lower parts of the chalk formation.

We have, then, I think, satisfactorily accounted for the *quantity* of water which is found in our county when a boring is made into the chalk from the surface. Whether or not we conclude with the Rivers' Pollution Commissioners, that we have here, within a circuit of 40 miles from the metropolis, a natural reservoir of pure water, amply sufficient for its present wants, as well as for a long

time to come for its ever-growing population; there can be no doubt, that for the *extra*-metropolitan part of our county, we have directly under our feet a practically inexhaustible supply. Thus, our interest in the *quality* of that supply is direct, and anything bearing upon it of immediate practical interest. But before addressing myself to this question, I must say a few words more as to the flow or motion of the water through the chalk.

I said just now that if a well were sunk at this place into the chalk, the water would rise up in it until it stood at about the level of the sea. Now, the water in a well in the open chalk country, say north of Watford, would stand at a level of some 250 feet or upwards above the sea level, and we know that if a free and closed communication were opened (say by an iron water main) between such a well and our well here, the water would rise to the same level—or rather, the surface here, being only about 180 feet above the sea, would overflow. If, however, the pipe were partially choked, and if it were also tapped to feed other places at lower levels, the level to which it would rise here would be certainly lowered. Now, this is what we must conceive really happens in the chalk beneath our feet: the passage of the water is obstructed by the solid chalk itself through which it can percolate but slowly, and large volumes of water are carried off to feed the lower springs which supply the Thames. Hence it is not surprising that the water in our wells does not rise to anything like the level of the source whence it is derived. From a careful tabulation of the heights to which the water has been found to rise in numerous wells in the Thames Basin, Mr. Joseph Lucas, late of the Geological Survey, has been able to lay down on the maps, which I have here, and which he terms Hydrogeological maps,* a series of lines, along each of which it may be expected that water would rise, in wells sunk into the chalk, to the same level above or below the O.D. Along one line, for instance, which passes through Kensal Green, Kilburn (very near the site of this building), the south part of Hampstead, Highgate, and a little south of Hornsey and Tottenham, Mr. Lucas tells us the water would rest exactly at the level of the O.D. Proceeding north-

* Published by Stanford, May, 1878.

wards or N.W. from this, we come to lines in succession in which it would rise 10, 20, 30 feet *above* the O.D., while to the S.E. we should come to lines along which it would rise to levels 10, 20, etc., feet *below* the O.D. There is much to be learnt from these maps, which the limitations of time and my proper subject prevent me from now entering on. I would merely remark further, that these lines, if correctly laid down, enable us to determine the general direction of the flow of the water in the chalk at any place, which, as the water must move from the higher to the lower level—that is, from the place of higher pressure to that of lower—cannot deviate much from the direction at right angles to the line of equal level through that place.

As to the *quality* of the water in the chalk, considering the extent and position of the gathering ground on the chalk-hills which surround the Thames basin, there is obviously little chance of any organic impurity polluting it; and if there were such pollution in certain localities, it would in its long course through the chalk beds clear itself, both by dilution with water from uncontaminated sources and by becoming oxidised, and so rendered innocuous. Its organic purity is, therefore, unquestionable. We should expect, however, to find a considerable amount of inorganic and mineral matter dissolved in the water. For, though chalk is almost insoluble in pure water, water which contains (as rain water always does) a certain quantity of carbonic acid readily dissolves it. Chalk (chemists tell us) is carbonate of lime (calcium carbonate), with about 2 per cent. of clay and a little silica; sometimes also containing small quantities of magnesia and calcium chloride. The carbonic acid of the water combines with the carbonate of lime to form bicarbonate of lime, which is soluble in water. Thus, in the chalk water a considerable amount of calcium may be expected to be held in solution, and very little else; and we should probably expect *a priori* that, as the water remains in the chalk, very little variation would be found in its constitution in different localities. Such, however, as I shall proceed to show, is very far from being the case, even in wells in which the entry of all water from the surface or from strata above the chalk has been carefully and effectually guarded against.

Let us first examine water from wells in the chalk, where it is

not covered by overlying strata. I find from the Sixth Report of the Rivers' Pollution Commission (pp. 100–1) that out of 42 instances of such wells, excluding 12 as exceptional, either from indications of more or less pollution, or as affected by the infiltration of water from the Thames (as at Grays, Erith, Plumstead, etc.), there are 30 instances of apparently normal character, in which the total solid matter held in solution varies between 233 and 384 parts per million, the mean being 331 such parts; and that in these the hardness varies between 19° and 32°, the mean being 25·8.° The Watford water may be taken as typical. Its analysis in detail is given in the column headed A in the Table on p. 157. With respect to water from deep wells in the chalk beneath the London clay, I find (Rivers' Pollution Commissioners, 6th Report, p. 103) that out of 11 instances in the Thames basin, excluding 2 as exceptional (to be presently considered), there remain 9 instances which may be regarded as of normal character, and in these the total solid matter held in solution ranges between 330 and 840 parts per million, the mean being 672 such parts; also, that the hardness ranges between 6° and 17½°, the mean being 10°.

A comparison of these two results at once forces on our attention the remarkable fact that while the quantity of total solid matter dissolved is much larger on the average in the water from the chalk where it is covered by the London clay than in that from its outcrop, and also ranges between much wider limits, yet the hardness is on the average very much less, though this also ranges between somewhat wider limits.

This want of relation between the amount of solid constituents and the hardness of the water indicates a totally different mineral constitution in the two kinds of water. This, then, requires examination in detail, and for this purpose I have put together a number of analyses in the subjoined table (p. 157), derived mainly from tables in Watts's Dictionary of Chemistry. In this table the column headed A gives the normal composition of water from the open chalk; those headed B the composition of various waters from the chalk beneath the London clay, regarded as fairly normal types; while those headed C refer to certain exceptional waters from the same.

Analyses of Waters from Artesian Wells sunk into the chalk beneath the London Clay, for comparison with that from the Chalk, where not covered with overlying strata, and with one another. (Expressed in parts per million.)

		A	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	C_1	C_2	C_3	C_4
Total Solid Contents	...	338	991	536	649	806	738		682	810	573	685	—	884	1280	567	942
(Riv. Poll. Com.)	...	(352)	(834)	(840)				(733)									
Calcium	Ca	110	19	20	25	35	15		13	19	22	29	(91)	68	69	47	49
Magnesium ...	Mg	—	9	6	12	4	10		3	7	14	19		53	89	26	45
Sodium	Na	11	265	175	219	248	237		176	155	169	87	279	170	239	84	199
Potassium ...	K	—	99	—	13	—	8		75	134	47	128	—	—	—	17	31
Carbonic Acid ...	CO_2	156	197	114	157	162	134		319	335	68	395	147	211	154	(157)	164
Sulphuric Acid ...	SO_3	7	181	127	121	239	158		183	222	76	183	99	267	603	84	287
Chlorine	Cl	12	174	90	97	110	139		111	150	154	86	114	123	124	41	149
Nitric Acid ...	NO_5	19	—	—	—	—	—		—	—	—	—	—	—	—	4	—
Silica	SiO_3	12	13	7	10	6	11		12	7	4	3	—	22	—	14	17
Organic	...	12	13	—	—	—	13		11	15	28	26	—	—	—	93	—
Sum of Constituents	...	339	970	539	654	804	725		903†	1044†	582	956†	730	914	1278	567	943
Hardness in degrees *: (From 6th Report of the Rivers' Pollution Commission.)																	
Temporary ...	...	21·9	3·0	7·7			6	4·5						20·0		15·4	15·5
Permanent ...	...	6·0	2·9	9·7			2	2·8						18·5		3·1	15·5
Total	...	27·9	5·9	17·4			8	7·3					6·0	38·5		18·5	31

* 1° Hardness = 1 part in 100,000 of Calcium Carbonate (Chalk), or the equivalent amount of some other Salt.

N.B.—To convert the above figures into *grains per gallon*, multiply by ·07, except the degrees of Hardness, which multiply by ·7.

† I am not aware how the analysts would explain the great discrepancy on these cases between the "total solid contents" and the "sum of constituents.

		AUTHORITY.	
A. Water from Chalk, not covered by overlying strata, at Watford		Campbell (Watts, D. of Chemistry, p. 1016)	
B. Water from Chalk beneath the London Clay :—			
1. Trafalgar Square ...	...	Abel and Rowney	do.
2. Royal Mint ...	...	Brande (Watts)	
3. Vauxhall ...	...	Odling	,,
4. Longacre ...	...	Graham	,,
5. Guy's Hospital ...	...	Odling	,,
6. Barclay's Brewery	...	Riv. Poll. Comm.	
7. Russell Square ...	...	Clark and Medlock	(Watts).
8. Westbourne Park ...	..	do.	do.
9. Hampstead ...	...	Mitchell	do.
10. Hanwell ...	...	Clark and Medlock	do.
11. Southall, Norwood (Middlesex), Waterworks	...	Attfield.	
C. 1. Harrow Waterworks (mean of)	...	Wanklyn, 1881. Liveing, 1882. Bloxam, 1883.	
2. Sheepcote Farm, Harrow...		Wanklyn.	
3. Kenton ...	...	Davies.	
4. Sudbury Brewery	...	Campbell.	

The following points are especially noteworthy :—

1.—That in A, fully four-fifths of the solids are chalk, the remainder being made up of sulphates, chlorides, and nitrates of calcium or sodium.

2.—That in B, as compared with A—

a. The total solid contents are more than double those in A (in almost all cases), and in some more than treble.

b.—The amount of calcium is reduced to a fraction, between one-third and one-eighth, of that in A.

c.—Magnesium appears to an inconsiderable amount.

d.—Sodium is enormously increased, and considerable quantities of potassium are found in several cases.

e.—Carbonic acid is in general somewhat increased, but in some instances diminished.

f.—Sulphuric acid and chlorine appear in considerable quantities.

This appears to indicate a substitution of soda for lime to a very large extent, and this substitution explains the loss of hardness in the water. Water which is hard owing to its containing

chalk (calcium carbonate) or magnesium carbonate may be softened in several ways. One of these is by adding carbonate of soda, which precipitates not only carbonate of lime and magnesia, but also sulphates, forming soluble bicarbonate and sulphate of soda.

Now, this process seems to be that to which the softening in the passage through the chalk is due. But whence comes the carbonate of soda? To this I can find no answer. From the fact that soda is found in considerable quantities in *all* cases of waters from the chalk under the London clay, it would seem to be due either to soda in the chalk itself—though I cannot find this mentioned as a constituent of chalk or as being found in the chalk—or to the influence of water from the overlying water-bearing sands, with respect to which I should be inclined to doubt whether the quantity is sufficient to produce so widespread an effect, even if it was shown that this would be one consequence of the mingling of these waters. It would be interesting to examine whether the softening is regularly progressive as the water passes inwards further and further away from the outcrop. Here, then, is a problem which, perhaps at some future day, our Society may assist in solving.

Other questions of a similar character will suggest themselves with regard to the sulphates and chlorides and to the magnesium, which seems to be a constant, though not in general a large constituent of the solid contents of the waters in question. But leaving these I will pass to the consideration of the waters in Section C in the table.

These waters will at once be seen to be exceptional in their character, in that, while, like other waters under the London clay, they have a large quantity of soda, they have not thereby lost anything like the same proportion (barely one-third) of the chalk they originally contained, and they have acquired an exceptionally large amount of magnesia. They are all taken from wells in the immediate neighbourhood of Harrow,* and their anomalies are doubtless due to some local cause extending over a limited area. Somewhat similar anomalies appear to present themselves at

* Measuring from the Harrow waterworks Sheepcote Farm is about $\frac{3}{4}$ mile east on the opposite side of the hill, Kenton about 2 miles to the north-east, and Sudbury Brewery about $1\frac{1}{2}$ to the south-east.

Colney Hatch, where an analysis shows Ca. 57 and Mg. 69, but Na. only 70, and CO_2, 126.

The result is that the Harrow water is excessively hard, and that so large a part of its hardness is permanent, that after the application of Clark's process, it still remains hard. Its hardness is also of a peculiar character. As it comes from the well, it has 14·8° of hardness and is therefore not a very hard water, considerably softer in fact than any of the London companies' waters derived from the Thames. When heated however to about 160° to 180° Fahrenheit a change takes place and its hardness increases to a maximum of 38·8°. By actually boiling the water the chalk in solution is precipitated and its hardness then becomes reduced to about 27° to 18½° If treated by Clark's process, its hardness becomes about 18° to 20°, or about that of Thames water, and at this it remains under all conditions of temperature.

The well at the Harrow Waterworks was sunk with such care to exclude the water from the sands in the beds above the chalk, that there can be no doubt that we are dealing in this case with water from the chalk alone. I have no information as to the well at Sheepcote Farm, which presents such a relatively large amount of magnesium and sodium sulphates as to render it quite unfit for domestic use.

The remarkable difference in so limited an area in the waters derived from apparently the same source need explanation. I can offer none better than the supposition that, within this area, the water from the sands above the chalk intermingle more freely than elsewhere from the absence of impervious separating beds, with the chalk water proper below.

It seems probable from the lines on Mr. Lucas's map that the sand-waters in the neighbourhood of Harrow are under a pressure, which would bring them in a well up to the level of 120 ft. above the O.D., while the chalk waters only rise to 102 ft., so that if there were free communication the sand-waters would penetrate into the chalk with a pressure due to a head of about 20 ft. Unfortunately, I have been able to get no analysis of these sand-waters so as to judge whether their constitution is such that their intermingling with the chalk waters would be likely to produce a water with such constituents as we actually find.

There is one other fact which seems to point to a similar conclusion. If the intermingling of sand and chalk waters is a very local phenomenon; supposing the supply of the sand-water not to be practically unlimited, it might happen that by continued pumping the sand-water would show signs of exhaustion, and its effect on the chalk water be proportionately diminished, so that possibly after a time its effect might be inappreciable. Now, the Harrow water has been examined at different times, though, unfortunately, we have no *full mineral* analysis of it at the earlier dates, but this is the result:—

In 1868, the total solid contents were 1044, and the hardness 48·5. In 1870 these were reduced to 1009 and 44·4 respectively; in 1873 to 981 and 40·8; and in 1883 to 884 and 38·5.*

This appears to show a progressive improvement in the water from the Harrow wells, and it would have been interesting, from a scientific point of view, to follow up these observations from year to year in order to see whether the change continued. Unfortunately for science, whatever the advantage to the inhabitants of Harrow from an economic point of view, this is no longer possible, for our pumps stand idle, and Harrow is now supplied with water by the Colne Valley Company, drawn from wells in the open chalk at Bushey.

Here, then, as far as my information extends, is another unsolved problem, which I commend to any members of this society who may have been interested in the facts I have brought before you this evening. I venture to hope that by the gradual accumulation of suitable observations, a satisfactory explanation of the anomalies to which I have called your attention (I fear with too great demands on your patience) may be found. I would merely suggest that possibly the solution of the anomalous character of the Harrow water may be found to be connected with the fact that at Pinner, about two miles to the north-west, the Woolwich beds rise up to the surface.

I will only add that as, though water is naturally *soft*, the influence of Harrow Hills appears to be to make it excessively *hard*, so

* Or possibly to 34·3, if calculated in the same way as at the previous dates.

you will kindly attribute it to a similar occult influence on the compiler of this paper, if he has therein proved to you that water can be made (at any rate as the subject of an address) very *dry*.

Eyes of Molluscs and Arthropods.*

By Dr. William Patten, of Naples.

Preparation of Young Pectens from 1-3 mm. long. I.—Molluscs.—1.—Specimens are placed in a mixture of equal parts of sublimate and picro-sulphuric acid. After ten or fifteen minutes they are washed in thirty-five per cent. and seventy per cent. of alcohol.

2.—The shells are then opened and the mantle dissected out with needles. Thus treated, the shape of the mantle is well preserved, whereas if removed before hardening it becomes much coiled and twisted.

3.—Each mantle edge may be cut, according to its size and curvature, into three or four pieces, and these will then lie sufficiently straight for convenient sectioning.

It is necessary to use a different reagent for nearly every part of the eye.

The Rods.—Chromic acid gives the most varied results according to the strength, time of action, and temperature of the solution, or by various combinations of these three. For instance, one-twentieth to one-fifth per cent. for thirty to forty hours failed to give any conception of the structure of the rods, while other parts of the retina, and of the eye itself, were well preserved; but when allowed to act for half an hour at a temperature of from 50° to 55° C., perfectly preserved rods with their nervous net-works are obtained; while, on the other hand, the remaining tissues become so granular and homogeneous as to be unfit for study. This treatment allows the rods to be removed in flakes and their ends examined without the aid of sections. *It is only in this way that the axial nerve-loops can be observed.*

* From *The American Naturalist.*

The Lens.—The lens is best prepared for sections by either sulphuric or picro-sulphuric acid. By the first reagent its shape is best retained, and the lens itself is less liable to be drawn away from the surrounding tissue; the latter reagent, however, brings out more sharply the configuration of the cells and allows a better stain of the nuclei to take place.

The Retinophoræ.—The retinophoræ are well preserved by nearly all the reagents; but in sublimate, in picric acid, or in their combinations, they become slightly granular, and remain so closely packed that it is difficult to distinguish the cell boundaries. Chromic acid, one-fifth per cent. for three or four days, contracts the cells and gives preparations in which the boundaries and general arrangement of the retinophoræ are easily studied.

Sections of the Eye.—In order to obtain the best sections of the adult eye with *all* the parts in the most natural position, it is necessary to treat them first with one-tenth per cent. of chromic acid for half an hour, then in one-twentieth per cent. for twenty-four hours; one-tenth per cent. for twenty-four hours; and finally one-fifth per cent. for forty-eight hours or more. Next to this method, it appears that solutions of sulphuric acid (twenty drops to fifty grammes of water) give the best preparations (for sectioning), of everything except the rods.

The double layer of the sclerotica and the fibres penetrating it can be seen in sections of eyes treated twenty-four hours in one-fifth per cent. chromic acid.

Maceration and Dissection.—The *pigmented epithelial cells* of Pecten's eyes and the cells of the *cornea* are easily isolated by treatment with Müller's fluid or bichromate of potash one-half per cent. for two or three days. For the maceration of all other elements weak chromic or sulphuric acid is used. For the outer ganglionic cells, which are very difficult to isolate, maceration in one-fiftieth per cent. chromic acid gives excellent results, after previously fixing the tissue in one-fifth per cent. for a few minutes.

For the *retinophoræ*, one-twentieth per cent. for four or five days proves very useful.

Sulphuric acid, five drops to thirty grammes of sea-water, gives the best results for the nerve-endings in the retinophoræ (not in the rods) and for the nervous inner prolongation of the outer ganglionic cells.

In order to isolate pieces of the cornea with the subjacent *pseudo-cornea* and the circular fibres on the outer surface of the lens, it is better to macerate the eyes in sulphuric acid as given above. The same treatment retains to perfection the natural shape of the lens, which may then be isolated and its surface studied to advantage.

It is necessary for the study of the *circular retinal membrane*, the *septum*, and the *retina* itself, to isolate the latter intact. Maceration in chromic acid either makes the retina too brittle or too soft, while the axial nerve-fibres remain so firmly attached to the retina that it is difficult to isolate it without injury. But this may be easily and successfully done by maceration for one or two days in the sulphuric acid solution. By this treatment the *retina*, together with the *septum* and *circular retinal membrane*, may be detached entire.

Surface views of the retina show the peripheral outer ganglionic cells. The *argentea* may be very easily separated in large sheets by macerating for four or five days in bichromate of potash of one per cent.

Sulphuric acid is a most valuable macerating as well as *preservative reagent*. In weak solutions (forty drops to fifty grammes) entire molluscs, without the shell, have been kept in a perfect state of preservation for more than six months. For cilia and nerve-endings it is exceptionally good.

The eyes of *Arca* and *Pectunculus* may be macerated either in Müller's fluid or chromic acid. Undiluted Müller's fluid in twenty-four hours gives more satisfactory preparations than a weak solution which is allowed to act for a longer period. Chromic acid, one-fifth per cent. for ten or twelve days, gave most of the preparations from which the drawings of the nerve-endings were made. A few drops of acetic and osmic acid added to distilled water give a very energetic macerating fluid for the epithelium of marine molluscs. Such preparations led to the discovery of the very delicate outward continuations of the pigmented cover-cells in the compound eyes of Arca.

II.—Arthropods.—In order to demonstrate the presence of the *corneal hypodermis* in the faceted Arthropod eye, and the connection of the so-called "rhabdom" with the crystalline cone

cells, it is necessary to resort to maceration. In most cases it is hardly possible to determine these important points by means of sections alone.

The ommateum of fresh eyes, treated for twenty-four hours or more with weak sulphuric or chromic acid, or in Müller's fluid, may be easily removed, leaving the corneal facets with the underlying hypodermis uninjured. Surface views of the cornea prepared in this way show the number and arrangement of the corneal cells on each facet. In macerating the cells of the ommateum it is not possible to give any definite directions, for the results vary greatly with different eyes, and it is also necessary to modify the treatment according to the special point to be determined. It is as essential to isolate the individual cells as it is to study cross and longitudinal sections of the pigmented eyes. In determining the number and arrangement of the cells and the distribution of the pigment, the latter method is indispensable ; it should not be replaced by the study of depigmented sections, which should be resorted to in special cases only.

In *fixing* the tissues of the eye, it is not sufficient to place the detached head in the hardening fluid ; the antennæ and mouth parts should be cut off as close to the eye as possible in order to allow free and *immediate* access of the fluids to the eye. When it is possible to do so with safety, the head should be cut open and all unnecessary tissue and hard parts removed. With abundant material, one often finds individuals in which it is possible to separate, uninjured, the *hardened* tissues of the eye from the cuticula. This is of course a great advantage in cutting sections. The presence of a hard cuticula is often a serious difficulty in sectioning the eyes of Arthropods. This difficulty can be diminished somewhat by the use of the hardest paraffin, and by placing the broad surface of the cuticula at right angles to the edge of the knife when sectioning. Ribbon sections cannot be made with very hard paraffin, but it is often necessary to sacrifice this advantage in order to obtain very good sections.

The Sea-Horse.*

By Samuel Lockwood.

THE July number of the *American Naturalist* for 1867 contains my article, "The Sea-Horse and its Young." Although the result of a long study of living specimens of this eccentric fish, yet some questions remain unanswered. At the time mentioned I was living at Keyport, on Raritan Bay. Early in 1870 my residence was changed to Freehold, fourteen miles inland; hence it has happened that specimens sent me have succumbed before reaching my home. A happy exception occurred November 1, 1884, in the arrival from Shark River of a fine large female, *Hippocampus heptagonus*, Rafin. As the subject of my article in 1867 was a male, I prized my new pet highly.

With an aquarium devoted entirely to this specimen, I set about studying her peculiarities. She had the same habit of converting her tail into a prehensile organ, and so would coil the tip around a tuft of sea-lettuce, and, with the pretty dorsal fin in movement like an undulating ribbon, would sway to and fro, keeping the body erect. The sight of the sea-horse alive in the water is always pretty, although quite grotesque, for its action differs so greatly from that of other fishes, which are prone, and usually move in a line parallel to the bed of the water, while, as a child would express it, the sea-horse swims standing up on its tail. The crested head is erect, the action, though stiff, is graceful, not unlike the knightly steeds on the chessboard, very quaint yet comely.

I had through all those years desired to see the giving of the spawn by the female and the taking of it by the male; for, as shown in that article of 1867, the male Hippo is not only father but nurse to the young. In his front, just a little higher than the vent, is a sac, into which he receives the eggs of the female, and in which he hatches them. My desire was to see the method of taking the eggs into this pouch. Did he put them in or did she? Despairing now of ever seeing them in apposition, I must describe the act as I think it does take place.

* From *The American Naturalist.*

I cannot believe that the twain are without emotion, since it is true of some of the higher fishes that the love-season calls out their intelligence to its highest manifestation. Suppose in our latitude it is July. A pair of these Hippocampi meet. They curl their prehensile tails about each other and assume an erect position, face to face. The female emits her eggs in a slow stream immediately over the pouch, which opens and closes at the top. The motion of the mouth of this sac is that of suction; thus, the eggs are actually drawn into it. There they are patiently hatched and also nourished, as shown in the paper referred to. This apposition of the sexes, to be sure, is hypothesis, yet I think it will prove to be true. At any rate, it is the outcome of long and patient thought, and is perfectly consistent with observation of habit.

When the young are ready for eviction, the pouch, which on receiving the eggs was fat and thick, has become flaccid and thin. Its adipose lining has been absorbed by the young fishes. So badly wasted is the pouch that muscular action sufficient to expel the brood is impossible. The father-fish evicts his charge in the following way. He gets himself in an erect position alongside of some object—a stick, stone, shell, or plant—either hooking the end of his tail under it, or in some way getting hold by its prehensile tip. Then stiffening the whole body and keeping it erect, he leans upon the object, and brings himself down against it with a jerky movement; this rubs up the pouch, pushing out some of its occupants. This is done repeatedly until the whole brood is forced into the water.

Now, it is observable that an anal fin would be greatly in the way during such an operation. In fact, it would be a very bad obstruction. Hence the absence of this fin in the male Hippocampus. But it is present in my female, for in her case it is not in the way. In fact, it may be that she utilizes it at the time of emitting her spawn, as she could produce a gentle eddy of the water in the direction of the male's pouch.

I found by the microscope that diatoms were being generated in the tank, and I fancied that my pet was feeding on them, for in all my devices I did not succeed in feeding her myself. She would show a movement in her tubular snout which looked like sucking

something in. Sometimes she would stretch herself on the bottom of the tank, and apply the tip of her nozzle in a way that seemed to me like selecting by sight. And what a cunning look! as with sacerdotal steadfastness of purpose one eye was turned towards heaven and the other kept upon the earth. Certainly her food was microscopic, and in the hunt her optical application was binocular or monocular at will.

I noticed with some concern that the peculiar scales which covered its body, and looked not unlike plate armour, were becoming green. It proved that a growth of micrococci had set in, and was rapidly spreading over her. I was quite solicitous about it; for it would hardly do for me to clean it, so tender is the little creature. Its tank had become badly infested with these unicelled algæ. For the purpose of keeping up a supply of microscopic life for its food, besides the little two-gallon aquarium, I kept two specie jars going, and would transfer it to them, so that it could have freshness of food. Deciding to clean up the aquarium, I put it in one of the jars. It quite enjoyed the change, and to my surprise performed a series of movements on the clean sand which turned out to be successful efforts to scour off the green parasitical slime. It needed patience, but that, with perseverance, did the work.

She was in a few days put back into her aquarium. The little handling necessary always begat a discernible clucking as of terror. It was really a species of snapping of the lips of the tubular snout. I heard it often, and under different circumstances, and thought I could detect three intonings—one which was excited by terror, one denoting a pleasurable emotion, as when in play, and a third when quite still, perhaps faintly, like the purring of another pet. But perhaps my intense sympathy with the little creature may give colour to these interpretations.

Alas! there was now too much ground for sympathy—a terrible malady had begun to take hold of the poor thing. The face took on a comical aspect. On each side rose a swelling as if she had the mumps. With a hand-lens I found that these were blisters, white vesicles, and so buoyant as to annoy her by producing eccentric movements. I contrived to pierce them with a needle, and so to let out the confined gas. This gave immediate relief.

But they came again, and by-and-bye my surgery did not avail. They increased, and the buoyancy would raise it to the surface, and the little sufferer, despite all help, would float. And so it was on the last day of February, at an early hour, I found poor Hippie afloat on her beam ends and dead. I had her alive just four months, and the above is but a tithe of what might be told of her pretty ways.

The Microscope and how to use it.

By V. A. Latham, F.M.S.

Part XI.—Injecting, etc. *(continued).*

Sterling's Constant Pressure Apparatus (Plate XIV., Fig. 4).—Get a large, wide-mouthed bottle and a smaller one; have these well fitted with corks. In the larger cork bore four holes,* and in the smaller one two. Into two of the four holes in the larger cork fit two straight tubes, one passing nearly to the bottom of the bottle, the other passing for a distance of half-an-inch only through the cork. On this latter tube should be a stop-cock, and fitted above it a mercurial manometer by which the pressure is measured. This is simply a flattened S-shaped tube, turned through a right angle, one bend of which is filled with mercury. Behind this tube is placed an index board marked off in $\frac{1}{4}$ inches. Into the other hole fit a couple of tubes bent at right angles, each tube passing through the cork and projecting into the bottle for about $\frac{1}{2}$ inch, one of them having a stop-cock on the horizontal part of the tube. Into the two holes in the cork of the smaller bottle are fitted bent tubes, one of which passes to the bottom of the bottle, the other passing in for only $\frac{1}{2}$ inch. A tin cylinder holding a couple of pints of water is hung over a pulley fixed to the ceiling of the room by means of a cord. It can be raised or lowered at pleasure. An India-rubber tube is carried from the bottom of the tin to the straight tube which passes to the bottom of the larger vessel. Pressure from a water-main may be used in place of this last piece of apparatus. From the open bent tube

* The fourth tube, with the stop-cock for allowing ingress and egress of air, is not represented in the diagram.

of the larger bottle, a piece of flexible tubing is carried to the shorter bent tube in the smaller bottle, and attached to the longer bent tube in the smaller bottle is a flexible tube with a nozzle which will fit the stop-cock tube fitted into the cannula. The smaller bottle is filled with injection fluid, and both corks are fitted. The stop-cock in the short tube bent at right angles (in the larger bottle) is closed, and the tin vessel gradually raised; the water runs out into the larger bottle by the tube passing to the bottom; the air in this large bottle is gradually compressed, and is driven into the smaller bottle, and the increase of pressure drives the fluid out of the bottle and into the vessels which are to be injected.

The pressure in the vessels is indicated by the manometer, and is very readily regulated by merely raising or lowering the tin from which the water gets its "head," or by regulating the amount of water flowing from the main. The pressure should commence at $\frac{1}{2}$ inch of mercury, and be very gradually raised to 3 or 4 inches, according to the nature of the organ or tissue which is to be injected. Where the gelatine injection is used, the organ and the bottle containing the fluid must both be placed in a vessel of water, which should be maintained at a constant temperature of about, but never above, 104° F. (40° C.) for an hour before the injection, and during the time the injection is running. N.B.—Always fill the tubes with the injecting fluid before attaching to the cannula (the cannula having been already filled), in order that no air may get into the vessels.

Before proceeding to inject arrange the following instruments:—the syringe, thoroughly clean and in working order, with pipes, stopcocks, and corks shaped to stop the pipes while refilling the syringe, a few scalpels, scissors, dissecting forceps, bull's nose forceps for stopping up any vessel through which the injection may escape accidentally, an aneurism needle for passing threads round vessels, wash-bottle, floss silk or oiled worsted, and injecting fluid.

Killing the Animal to be Injected.—This is most easily done by opening it from anus to throat, and cutting deeply into the heart across the right auricle. It is, of course, done whilst under

chloroform, or immediately after it has been suffocated by chloroform. To facilitate the bleeding, the animal should be suspended alternately by the hind and front legs, and as the blood coagulates in the wound in the heart it should be removed. The best plan to administer the chloroform is to place the animal in a box, drop in a piece of cotton wool saturated with chloroform, and close the lid. In from five to fifteen minutes the animal will be dead.

To Inject a Whole Animal.—A rabbit is perhaps the best subject for a beginner. After killing it immerse the body in hot water for about fifteen minutes; then take it out, pass a ligature round the aorta close to the heart, make a longitudinal incision in the aorta, and insert a cannula of most suitable size. Bind the cannula firmly in the artery, and attach the stop-cock. Floss silk or oiled worsted are the best substances which can be employed for tying pipes in the vessels; it should not be drawn too tight or it will cut through them, and so permit the pipe to come out. All vessels must be opened longitudinally and under water: this prevents the entrance of air; avoid making the slit too large. If the cut be transverse the vessel may be torn in two, or contract so much as to be difficult to get hold of and so exclude the possibility of making an injection. Have a good supply of hot carmine mass (Dr. Carter's). First fill the syringe with the injection and then the stop-cock and cannula; then insert the nozzle of the syringe into the stop-cock, taking care that no air is admitted, or the passage of fluid will be impeded. The amount of pressure exerted on the piston should at first be very slight, but gradually increased as the injection proceeds. The filling of the spleen should be carefully watched, and as soon as fully distended, more injection mass should be prevented from flowing into it by tying a ligature round its artery.

The splenic artery is easily found. It arises as a branch of the cœliac axis, and enters the substance of the spleen at the hilus on its concave surface. In order to obtain a perfect injection of the kidney, it should be drained of all blood by opening the renal vein. Blood and carmine mass will at first flow out together; but as soon as the carmine flows out freely and unmixed with blood, the vein should be ligatured, and the vessels

allowed to fill slowly. When the transparent parts about the upper and lower extremities show a reddened and slightly distended appearance, the injection may be considered complete. The internal organs, when well injected, have a deep red colour, and appear as if inflated with air. In this operation, the lungs remain untouched by the injection, and they must therefore be injected separately through the pulmonary artery either *in situ*, or after excision. In order to render the capillaries of the alveoli perfectly distinct in section, it is usual to distend the air-cells of the lungs by pouring melted cocoa-nut oil down the trachea. The oil solidifies in cooling and makes the cutting of extremely thin sections after hardening an easy matter. When the injection is completed the open vessels should be tied, and the animal placed in cold water; half-an-hour afterwards the different parts should be dissected out, and placed in methylated spirit.

Injecting from Carotid Artery.—A much neater way to perform the above operation, though perhaps a little more difficult, is to inject from the carotid artery down towards the heart. First, cut down and expose the large artery and vein of the neck. Either dissect the vein out for a little distance, and then cut it, and hold the cut end over a beaker, or, better, introduce into the vein a small glass tube. Bleeding will freely occur through it. If a clot stops the flow, remove the tube and wash it out or introduce a wire and break it up; then secure the filled nozzle in the carotid artery. A small portion of the vessel is included between two clamps—flattened, bent wire—and a longitudinal slit made through its walls. After the pipe is well secured, a small quantity of the carmine mass is slowly introduced. The beat of the heart itself will push the mixture on until this first small quantity is seen to colour the gums and eyelids. It is advisable to open the abdominal cavity toward the latter state of the operation, in order that the organs may protrude and become generally filled with the injection mass.

Blood-vessels in Fish, as the Skate, etc.—I find the following a convenient way:—Have ready four of the movable cannulæ usually provided with injecting syringe, or if these are not at hand four glass tubes, drawn to the form shown in Pl. XIV., Fig. 5.

The smaller end is for insertion in the vessel, the constriction is for the purpose of preventing any slipping of the ligature, over the end of which a short piece of India-rubber tubing is pushed. Make an incision into the *conus arteriosus* (given off anteriorly and somewhat to the right side from the ventricle); place one cannula in it, directed forwards, and tie it firmly in its place. Tie the second, directed outwards, into the *sinus venosus;* the third, directed forwards (*i.e.*, towards the dorsal aorta) into the duodenal artery; the fourth, also directed forwards into the duodenal vein. Fill an ordinary tumbler half-full of plaster of Paris, coloured with a little common "French blue" or ultramarine of the oil-shops. Fill up the tumbler with water, stir well, and immediately strain the liquid through coarse muslin into a second tumbler. Fill the syringe, and inject through all four cannulæ successively. This must be done very rapidly, or the plaster will set. On removing the syringe from a cannula, the India-rubber tube should be plugged with a small piece of wood to prevent escape (keep a few pegs ready made which fit well). All the chief vessels are injected in this way: the ventral aorta and its branches from the *conus arteriosus*, the systemic veins from the *sinus venosus*, the dorsal aorta and its branches from the duodenal artery, and the postal vein from the duodenal vein. The caudal and renal postal veins have to be done separately; the femoral and ilio-hæmorrhoidal veins also often escape being filled. If a preparation for demonstrating purposes be desired, it is advisable to colour the plaster used for injecting the dorsal aorta with vermilion or carmine instead of French blue.

A Fine Injection for very Small Vessels is made by straining through muslin a strong solution of gum arabic in water coloured with precipitated Prussian blue or carmine. After injection, the subject is placed in alcohol, which coagulates the gum. It has a double advantage over gelatine—that it is used cold and that it keeps better in alcohol. A common brass ear-syringe, holding about two ounces, answers for every purpose, using for cannulæ glass tubes as above form, adapted to the nozzle of the syringe with short pieces of caoutchouc tubing.

Injecting a Green Lizard.—Render the animal insensible with chloroform; lay bare the heart, taking care not to injure the epigastric vein; slit open the pericardium, and cut off the apex of the ventricle. When the bleeding has stopped, push a cannula through the wound into the cavity of the ventricle, and thence into the right aorta, and tie it in place by a ligature round the base of the ventricle. A warm solution of gelatine, covered with carmine, vermilion, or French blue (ultramarine), is the best injecting medium. It is firm enough to pass through capillaries, so that the whole vascular system, with the exception of the pulmonary vessels, can be injected at one operation.

Injection of Pigeon.—As soon as the bird is dead (kill with chloroform or potassic cyanide), pluck the breast, expose the pectoral vessels of one side, cut through these vessels as near as possible to the reflected *pectoralis major*, and allow to bleed. All this must be done very quickly, as birds' blood coagulates very fast, and it is essential to success to allow as much as possible to escape. Remove the *corpus sterni* on the same side so as to expose the heart, and see the origin of the pectoral vessels. Insert a cannula into the pectoral artery through the incision already made, tie securely, and inject towards the heart. In this way the whole of the arterial system is filled. The systemic veins may be filled from the pectoral vein, but better results are obtained by injecting from the coccygeo-mesenteric vein, the cannula being inserted backwards, or towards the renal postal veins. The severed pectoral vein should first be tied or clamped with bull-dog forceps. It will probably be found necessary to inject the precavals (*vena cava* superior, anterior dextra, a large vessel, situated dorsal and external to the right innominate artery, formed by union of jugular, trachial, and pectoral) and their feeders separately. This is best done by making an incision in one of the jugulars (preferably that of the side on which the pectorals have already been cut), near its proximal end, and injecting forwards. The postal system is best injected from the coccygeo-mesenteric vein, the cannula being directed forwards.

Injection of Rabbit.—Kill with chloroform or potassic cyanide. As soon as it is dead, open the thorax by cutting through the

sternal ribs of both sides sufficiently far from the middle line not to injure the mammary arteries, cutting across the posterior end of the sternum and turning it forwards. Slit open the pericardium, and make a large incision, by a single cut of the scissors, in each ventricle. All this should be done rapidly (if possible, before the heart has ceased to beat), as it is desirable to get rid of as much blood as possible. Pass a ligature round the aorta close to its exit from the heart, and give it a single loose tie. When the bleeding has ceased, sponge the blood from the heart, and pick out any clots which may have formed in the left ventricle, pass a cannula through the incision in the left ventricle into the aorta, tighten the ligature, and knot it firmly. By this operation, the whole of the systemic arteries are injected. The pulmonary arteries may be filled by proceeding similarly on the right side. The postal vein is readily injected from its branch to the caudate lobe, the cannula being directed towards the main trunk. The injection of the systemic veins is more difficult. The precavals may be filled from the external jugular, the post-caval from external iliac, the cannula in both cases being directed towards the heart. For anatomical purposes, injection with plaster is the best.

Injecting a Frog.—Kill with chloroform. Introduce one blade of the scissors carefully beneath the sternum, and cut it through the median line. Slit open the pericardium and the fleshy part of the heart, seized with forceps. Cut an opening into the ventricle. Do not wait long for the blood to escape, but wash it away with the wash-bottle as it appears. Introduce the filled pipe of the syringe, and secure firmly in place by passing the thread around the heart-substance and back over the pin on the nozzle. Just the end of the pipe should be included, for if it is thrust too far, there is great danger of the point passing through the delicate coats of the vessel.

Injecting Eye of Ox.—The pipe is inserted in the artery close to the nerve. Two or three minutes will be time enough to make a complete injection. If the globe becomes very much distended by the fluid, an opening must be made in the cornea to allow the humours of the eye to escape. Thus space is left for the injection, and the vessels may be completely distended.

Rat, Mouse, or Frog.—Inject from the aorta.

Injecting Insects.—Insects may be injected by forcing the fluid into the general abdominal cavity, whence it passes into the dorsal vessel, and is afterwards distributed to the system. The superfluous injection is then washed away, and such parts of the body as may be required removed for examination. Insects should be injected very soon after they have emerged from the pupa. The water vascular apparatus, vessels, and the digestive tube may be injected. In some cases the best results are obtained with size coloured with transparent colouring matter; in others by injecting Prussian blue or carmine fluid made with glycerine. In injecting the digestive apparatus of some entozoa, as liver fluke (*Distoma*, or *Fasciola hepaticum*), the pipe may be tied in; but I only make an opening into the vessel and insert the pipe, which must be held steadily while the injection is carefully forced from the orifice.

Injecting Mollusca (slug, oyster, snail, etc.).—The tenuity of the vessels of many mollusca renders it undesirable to tie the pipe in them. The capillaries are, however, very large, so the injection runs readily. In different parts of the bodies of these animals are numerous lacunæ, which communicate directly with the vessels. If an opening be made through the integument of the muscular foot of the snail, a pipe inserted, and the lacunæ filled easily, the large vessels of the branchiæ may be readily injected with the aid of a pipe having an orifice at the point.

Injecting Snails (Robertson's plan).—Kill the snails by drowning them in a jar quite filled with cold water, the mouth closed with a piece of plate glass. The vascular system is to be injected from the ventricle of the heart with size and carmine. The heart of a snail is easily found. It is enclosed in a sac, which is situated at the posterior extremity of the pulmonary chamber on the left side. The position of the organs of a snail has been fully described by Dr. Lawson in the *Microscopical Journal* for 1863. The injection, introduced into the heart, passes right round the body and returns to the pulmonary chamber. By this plan the arterial

branches may be traced into the foot and to many other parts which were considered to be destitute of arteries.*

Injecting Fishes.—It is difficult or quite impossible to tie the pipe in the vessel of a small fish. If we inject from the heart, the fluid passes through the gills. The best way is to cut off the tail of the fish, introduce the pipe into the divided vessel which lies immediately beneath the spinal column. In this manner beautiful preparations may be made.

Double Injection of the Eye and Spleen.—It is well to drive the injection mixture intended for the venous system through the artery first, and then through the same vessel the second mass which is to serve for the arterial system. Not unfrequently the injection may be essentially regulated by keeping open or closing the terminal vein. The beginner often experiences a difficulty in finding the vessel from which to inject; and to distinguish the arteries from the veins. This may be found by making a longitudinal incision in the vessel, and with a blunt, thick needle probing a little distance into the tube. The artery will be found thicker in the coating than the vein, and the difference is easily perceived by this mode of testing. The vein is also of a bluer colour than the artery.

A sheep's foot injected forms a good object. The liquid should be forced into it until a slight paring of the hoof shows the colour in the fine channels there. The tongue of a cat is also a very beautiful injection. A solution of tannin, injected after washing with warm water, renders arteries impervious to the coloured fluid afterwards thrown in. A little practice will enable the beginner to overcome the difficulties of injection. A few failures may be expected at first, but after three or four trials perfection will soon be gained. Careful dissection and attention to the directions here laid down will save much labour and loss of time. The injection of single organs—as liver, lung, etc.—will be treated of under the preparation of the same in a future part.

Injecting Annelids.—For annelids with dark tissues, like *Hirudo*, a light-coloured (white or yellow) injection-mass should

* On "The Organs of Circulation of Helix Pomatia," *Annals and Magazine of Natural History*, Jan., 1867.

be employed, while for transparent animals dark colours are preferable. Chrome yellow serves the purpose. It is easily obtained by mixing solutions of bichromate of potassium and acetate of lead. A copious yellow precipitate is formed, which must be washed on the filter, then exposed in the air until nearly dry. The pigment, after it is reduced to a pulpy state, is added to an ordinary aqueous solution of gelatine, and the mass then filtered warm through linen. If a blue mass, the gelatine may be dissolved directly in liquid Prussian blue and filtered through paper. Chloroform and alcohol are the best means of killing annelids for this purpose; fresh water may be also used for some marine species. A leech is placed in water in which is a small quantity of chloroform; after a few moments, it sinks to the bottom and remains motionless. It is better if it remains in the solution for one or two days before beginning to inject it. A well-stoppered bottle must be used, as chloroform evaporates so quickly. The best form of syringe consists of a glass tube drawn to a fine point at one extremity and furnished at the other with a rubber tube. Preparatory to injecting, the glass should be plunged in warm water for a few minutes. Then expel the water and fill with the injection fluid by sucking the air from the rubber tube. If the mass is turned into the large end of the glass, granules are introduced which are large enough to obstruct the narrow opening at the small end. Insert the cannular end in the vessel, clasp both with forceps, then force the fluid, by aspiration, through the rubber tube, which is held in the mouth. When the injection is finished, place the animal in cold water, to stiffen the mass.—M. T., *Zool. Stat. Neapel.*

Hardening Injected Tissues.—Injected tissues must be hardened in spirit. After the first day's immersion, they should be transferred to fresh spirit for two more days, and then again into fresh spirit, and kept in this until ready for cutting into sections. It is never necessary to use absolute alcohol, and it is seldom needful to place the tissues first in weak spirit and gradually to increase the strength up to perfectly anhydrous alcohol. The length of time required for hardening depends upon the kind of tissue, its size, and, to a certain extent, upon the quantity of spirit used. The smaller the size of the tissue, the more rapidly will

the hardening be done. Brain, spinal cord, and kidney are rendered sufficiently hard for cutting in three weeks; lung, liver, spleen, pancreas, intestines, tongue, etc., take a longer time, usually from five to eight weeks. A saturated aqueous solution of picric acid is sometimes used as a hardening agent, but its action has a very persistent yellow dye, which is much against its employment for this purpose.

Another method for Hardening the Tissues.—After injection I place the object at once in equal parts of alcohol and water; allow to remain for some hours, so that the gelatine becomes solid. If carmine mass has been used, alcohol and water is the only suitable fluid for hardening, and a few drops of acetic acid should be added, to prevent diffusion of carmine. If Prussian blue, either alcohol, Müller's fluid, or picric acid may be used. Some recommend a $\frac{1}{4}$ per cent. solution of osmic acid. But it must only be used for small pieces, as it does not penetrate far. For those readers who wish for further information, I would recommend Robin's "Du Microscope et des Injections," Frey's "Das Mikroskop," etc., "Journal of Royal Micros. Soc.," etc.

Half-an-Hour at the Microscope,

With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

PLATES 18, 19, 20.

Æcidium compositarium, var. *C. Tussilaginis*, being, as it should be, mounted to show both surfaces of the leaf, we are enabled to gain a view both of the "*Cluster-cups*" on the *under* surface, and of the "*Spermogones*" on the *upper*.

How the contents of the latter, representing male organs, situated on one side of a leaf, gain access to the former, on the opposite side, is a question deserving of careful thought and observation. I am inclined to think from what I have seen that it is through the agency of insects. The Æcidium of the lesser Crowfoot is very abundant here in its season, about April; at such time "sun and showers" are proverbial, and I have often noticed flies about on the bright, shining leaves. Now, it is easy to suppose that the viscid substance containing the "spermatia" may adhere to their feet, and so be carried to the "Cluster-cups"

as they pass from one leaf to another. Some Acari also are frequently found revelling amongst some of these leaf-fungi; as well as the larvæ of some "Thrips," and (speaking from memory) I think some other minute larvæ also.

From considerable experience, I feel persuaded that many of these leaf-fungi are *very local.* Mr. M. C. Cooke speaks of the present one as "common" (p. 193), but though often searching for it I never found it but once, and that was on Coltsfoot growing in a deep, narrow, dry ditch at Hunstanton on the Norfolk coast about 8 years ago. There it occurred in very fine condition.

I believe myself that the *Coleosporium Tussilaginis,* so excessively common as bright orange patches on the under surface of Coltsfoot leaves, is nothing but the same thing growing in a random sort of way under unfavourable conditions, but this is utterly heterodox, and I must seek to emulate the stoicism of a Red Indian under the merciless treatment I may expect to receive from one of our members for venturing to have an opinion of my own.

Dolichopus simplex.—(Pl. XX., Figs. 1—2). I would draw attention to the antenna, as it furnishes one of the characters of the genus. "Third joint of antenna trigonate, with a pubescent dorsal seta." I have been much struck with the remarkable arrangement of the "eyelashes" in connection with the ocelli and the compound eyes. Two strong bristles arise from a little in front of the posterior pair of ocelli on lines which would form the sides of a triangle (Fig. 2), at each angle of which an ocellus is seated. Now continue in imagination these sides of the triangle for an equal distance behind, and at the lower angles of the projected triangle we find two more strong bristles. Can we help seeing design in all this? Is it not as evident on consideration as that manifested in the various arrangements of our own eyes? And then, again, we find an eyelash protecting each compound eye, with the number 4 again present. I cannot tell just the direction in the specimen before us, it having been disturbed, but in the blue-bottle and smaller house-fly it may be readily seen by putting one bodily on the stage of the microscope. The former, I think, has five or six setæ on either side, arching over the ocelli; the latter has ten on each side. They form beautiful objects.

Cuticle of Darnel Grass is from the stem of "*Lolium perenne,*" the common or perennial Darnel. It shows an interesting structure which was described by the late Rev. J. B. Reade and Prof. Quekett as "Little cups of Silica." The indulation of the walls in seven lines of stomata-bearing cells, the entire absence thereof in the intermediate lines of cells, are points well brought

out in the slide before us, and connected with essential and most important differences in the subjacent structures.

Palate of Testacella Haliotidea (Pl. XVIII.).—I do not know this creature, but think I remember to have seen that it is carnivorous; certainly the teeth are most formidable weapons, and would be admirably calculated for cutting through tough substances. The resemblance borne by each individual tooth to the "coulter" of a plough, as remarked by the owner of this slide, seems to me interesting and worthy of notice.

Snipe-Fly, Empis tesselata.—The passing round of slides of typical specimens will, it appears to me, be one of the very best aids we can adopt towards our mutual improvement. Viewed from this point of view, I regard the present slide as a valuable one. Although objecting on principle to the crushing flat of insects, there is still much to be learnt by the careful study of such a specimen. I find that such are excessively popular with those to whom the microscope and its revelations are not familiar, but as students advance in knowledge they come to be regarded with proportionately less favour.

Hemipteron? (Pl. XX., Figs. 3—6).—I incline to think this is a mature insect, *a female with the wings undeveloped;* we obtain a partial view of a very fine ovipositor-saw which seems to say so. On this it may be interesting to quote for those who have not the opportunity of referring, the following remarks by Westwood:—"A peculiarity occurs in some of these insects whereof analagous instances have already been noticed among the *Orthoptera*, *Homoptera*, *Aphidæ*, and even in a species of *Chalcididæ*, namely, the undeveloped state of some specimens in the imago state which are nevertheless as capable of reproduction as others of the same species which have acquired fully-developed wings. Thus the bed-bug has never been observed but with the minute rudimental upper wings, somewhat resembling the ordinary wing-case of pupæ; others, again, as the species of *Gerris*, *Hydrometra*, and *Velia*, are mostly found perfectly apterous, whilst occasionally they are found with full-sized wings. The winged males of *Capsus ambulans* are stated by Fallen to be always found coupled with apterous females. *Chorosoma miriformis*, *Prostemma guttata*, *Pachymerus brevipennis*, etc., are generally found with very short wing-covers, but occasionally with full-sized wings."—(Introduction, Vol. II., p. 454).

This has a considerable *general resemblance* to the bed-bug; does the mounter remember exactly *how and upon what* he caught it? Many are very local, as he will find by referring to Douglass and Scott's monograph of the order (Ray Society's Vol., Introduction, p. 6). The best way on finding another specimen would be

to submit it at once to them for naming. Many structural details are shown more truthfully in this specimen than in the crushed mounts, the corneal facets are more finely brought out than in any mounted insect I have ever seen; and there is this peculiarity, that they are as round as if made with a circular punch! (see Figs. 4, 5, Pl. XX.) instead of being hexagonal, as is commonly the case, or passing from that into square, as we occasionally find them. And there is a noteworthy thing in the right eye—two corneal facets run together, a thing I have not before met with, and corresponding in its character to the occasional abnormal developments in the eyes of spiders noted by Blackwall.

Wing of Bombus terrestris.—In the *Hymenoptera* the wings consist of a pair called "anterior" and "posterior" on each side. One of the "characters of this order consists in the connection during flight of the two wings on each side of the body, by means of a series of minute hooks along the anterior margin of the posterior wings, which catch the hinder margins of the anterior wings, thus producing one continuous surface on each side" (Westwood, Introduction, Vol. II., p. 76). Analogous contrivances for uniting the wings during flight are met with in some other insects. In the Lepidoptera, where present, these assume the form of a loop and bristles (*Loc. cit.*, p. 317, and Fig. 102, p. 365). It may be as well to mention that a paper was presented to the Linnæan Society by Miss Staveley, entitled, "Observations on the neuration of the hind wings of Hymenopterous insects, and on the hooks which join the fore and hind wings together in flight," containing much interesting information on the subject, and will be found in the 23rd vol. of their transactions, p. 125, with a plate.

Spiral Fibres, Petiole of Garden Rhubarb.—This is a very interesting specimen, especially when examined in connection with Dr. Moore's notes upon it. I had no idea my old friend, Dr. Bristowe, had been turning his attention to the development of spiral and pitted tissues in plants, but will take an early opportunity of consulting his paper. The late Prof. Henfrey says:—"The mode of formation of the secondary deposits is not clearly known at present. Some imagine them to be precipitated from the cell-sap upon the walls; others, and apparently with more reason, believe that they are attributable to the agency of the Primordial Utricle, continuing its action after the formation of the primary membrane. Crüyer goes so far as to consider the spiral markings, etc., as dependent on the Rotation currents of the protoplasm. These points require further investigation" (Mic. Dic., p. 617). And in special connection with spiral structures, he says:—"It has been stated that the various forms of the open spiral, annular and reticulated deposits are modifica-

tions of the simple close spiral; but this must be understood only in a metaphorical sense, since there is no actual change of condition ensuing with age, as has been assumed by some authors, the fibrous layers being always originally deposited on the primary wall in the form and pattern which they ultimately possess. There appears to be no real openings of the spirals or breaking up into rings, in consequence of the expansion of the primary wall to which they are attached" (*Ibid.*, p. 638). It is probable the question will never be definitely settled till they have been actually witnessed as being laid down, under high powers of the microscope.

Lord Godolphin Osborne paid special attention to the subject, attempting by growing wheat in shallow glass tanks to view the process. Some of these tanks were sufficiently shallow to allow of the use of the ¼ inch object-glass; in them was placed a weak solution of ammoniacal carmine. He succeeded in viewing the formation of pitted tissues, but that of the spiral vessels completely baffled him. He says:—"In the leaf of the wheat I find the true spiral—the annular, the scalariform; in the roots I find only the latter, with an accompaniment of dotted tissue. At the very earliest stage at which, by dissection, a view can be obtained of leaf and root formation, the fibres proper to each are discovered—the spiral completely formed, the scalariform in active formation, the former turning upwards to the leaves, the latter separating into bundles and going downwards to the roots. The formation of the scalariform fibre can be with ease traced" (p. 11). There can be no doubt a thorough study of pitted and spiral structures, *as a system*, would yield most interesting material. And I hope to be excused for quoting one of the concluding remarks of the paper alluded to:—"In my opinion, no student of animal physiology can pursue this course of research without being struck with the very strong analogy existing between the development of vegetable and animal structure. I will not trust myself to enter into this subject further than to declare that every day's work on vegetable structure has given to me a new interest in every page which I read relating to the structure of animals. I cannot but think we are approaching a time when the microscope, in the hands of men of science, will prove in these two fields of God's wonder-working, the existence of a strictly analogous principle, developing and sustaining animal and vegetable life, with only that much of difference in the processes which the obvious purposes of the two existences would lead one to expect" (p. 120, Q.J.M.S. transactions, Vol. V., 1857).—"Vegetable cell structure and its formation, as seen in the early stages of the growth of the wheat plant," by the Hon. and Rev. Sydney Godolpin Osborne.

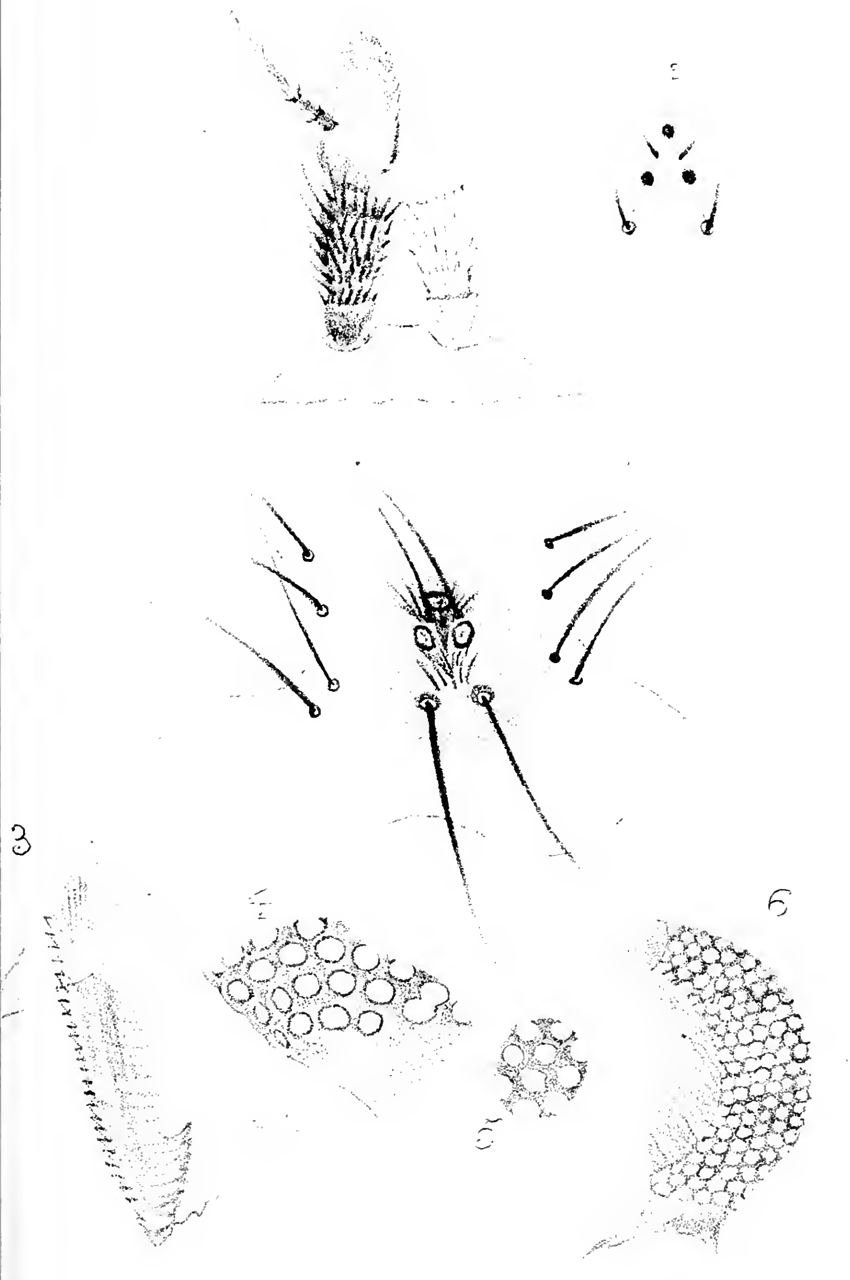
Section of Yew.—This being a transverse section only tells

part of the story of the wood of the Yew. In examining wood, it is desirable to make a transverse section first; this furnishes a *key* to what structures are to be looked for. Then, if the bark be present, take a thin piece of the outer layer of cells (epiderm, of authors); the form of the cells composing it, their contents, and the presence or absence of stomata are to be remarked. Then, if the bark contain liber-fibres (the tissue constituting hemp, flax, and the like), a longitudinal section to display them is requisite. Another longitudinal section, just a little within the outer ring of wood, follows: this is called a "*vertical tangental section*"; it yields important facts as to the medullary rays and the woody fibres in one aspect. Lastly, a thin longitudinal section is made right through the centre, parallel to the medullary rays; this is called a "*vertical radial*" section. Building the facts obtained by these means into a whole, a complete idea of the structure of any wood is obtained. The rich red-brown resin, so commonly met with in Coniferous wood, is well shown in some of the cells, notably in those of the outer bark (ectophlœum). The stem from which this was cut had taken twelve years in its formation, and illustrates well the slow rate of growth in the Yew. It is interesting also to note the great eccentricity in the various rings—the narrow portion had a north aspect; the wide parts of the rings, the south. Then look at the inner portion of each ring towards the pith. In the spring of the year, after the winter's sleep, vegetation makes a sudden bound. The first-formed cells are large, with their long diameter from within outwards, indicating rapid formation. As the year wanes, the vigour of growth diminishes. The relative diameters of the cells are reversed; growth and sap-elaboration are more perfect; the cells form more slowly; have thicker walls; and then comes the period of hybernation again, when growth absolutely ceases; the record of that year's work is completed, and sharply marked out. Given the year in which the wood was cut, we might read off the meteorological conditions of that and the preceding eleven years:—some favourable to vegetation, others so much the reverse, that scarcely has the history of any work been added to the record.

It would have been specially desirable here to add the two vertical sections named, because in the Yew the wood has a very uncommon structure, *viz.*, a beautiful spiral fibre in addition to the so-called "glandular" appearance, ordinarily, though not quite correctly, supposed to be specially characteristic of Coniferous wood. The real distinction of such wood is the absence of pitted ducts and spiral vessels. Fossil wood having the structure of Yew may occasionally be found in Coal; the late Joseph Jackson Lister had a fine piece in his collection, from which he was good enough to allow me to take a drawing.

Teeth of Testacellus.

Campanularia volubilis.



Head of Dolichopus
Ovipositor & Eye of Hemipteron.

Campanularia volubilis (on *Ceramium ciliatum*, Plate XIX).—This beautiful zoophyte must have been lovely indeed in life, relieved by the delicate pink of the graceful Alga it made its home upon. A summary account of *Campanularia* will be found in the *Micrographic Dictionary*; Johnson's "*British Zoophytes*" may also be consulted, and a recent work on the same subject by the Rev. Thomas Hinck, B.A., F.L.S. The creeping main-stem whence the polypes arise must be carefully looked for; it is not readily seen, so closely does it adhere to that of the Alga. The animal has but one orifice, which serves alike for the reception of food and the voidance of effete portions. In life, a circulation of granular particles may be distinctly seen up and down the slender stems, and at times, though with more difficulty, along the main stem. The arms vary in number in different genera and species; here there are from fourteen to sixteen. Their motion is very slow, their action not consentaneous, as in the Bryozoa. They are rough and modulated along their edges; this arises from the presence of stinging organs, which consist of delicate filaments seated in capsules and ejected when required. In some of the larger Actiniæ—*e.g.*, *A. crassicornis*, the urticating effect of these organs may be sensibly felt when they are handled, and, under high powers of the microscope, seen when a small portion of the arm is examined. None shows them better than the common *A. mesembryanthemum*. At certain periods of the year ovicells are to be found; these are ovate vesicles concentrically ringed. They are not in the specimen before us, but I have added a figure *(a)* to assist in directing attention thereto.

Campanularia should be mounted in shallow cells; the cups are so very tender as to be crushed by even a slight amount of pressure.

T. West.

EXPLANATION OF PLATES XVIII., XIX., XX.

Plate XVIII.

Fig. 1.—Teeth of *Testacellus*, × 25.
,, 2.—Tooth from right side on its side, × 100.
,, 3.—Tooth from right side, ventral aspect, × 100.
,, 4.—Coulter of a plough for comparison, as suggested by a member.

Plate XIX.

Campanularia volubilis.—Two of the polypes are drawn from the specimen, along with a portion of the "weed," to which they are attached. The animal is from a figure taken from life at Looe in Cornwall, in 1857. The figure to the left (*a*) is of an ovicell.

Plate XX.

Fig. 1.—Parts of the head of *Dolichopus simplex*, illustrating the remarks on the antennæ, the ocelli, and eyes, and thin "lashes" or "guard"-hairs (see p. 180).

Fig. 2.—Diagram, showing position of ocelli.

,, 3.—Ovipositor of Hemipteron (? sp.), × 150.

,, 4.—Hinder part of right eye, showing partial fusion of two facets, × 200.

,, 5.—Corneal facets, central portion, × 200.

,, 6.—Left eye, × 75. Drawn by Tuffen West.

Reviews.

THE COSMOGRAPHIC ATLAS of Political, Historical, Classical, Physical, and Scriptural Geography and Astronomy, with Indices and descriptive Letterpress. Third edition. (Edinburgh and London: W. and A. K. Johnston. 1887.) Price £1 1s.

This large and valuable atlas consists of forty political maps, including a chart of the world on Mercator's projection; nine historical maps, viz.:—England (Britannia) under the Romans, Scotland (Roman period), England (Saxon period), North Britain (Scotland, Saxon period), England (Tudor period), France, illustrating French and English wars, Europe from 1715 to 1815, North America, conquest of Canada, British-Indian Empire, 1757 to 1870; three classical maps:—the world as known to the ancients, Imperium Romanum, and Europe, showing barbarian inroads; four physical maps, viz.: an ethnographic map of Great Britain, rain-map of Europe, palæontological map of the British Islands, and the geological structure of the globe; four scriptural maps, viz.:—The distribution of nations after the deluge, the Holy Land (as allotted by Joshua), Palestine in the time of Christ, and the prevailing religions of the world; and six astronomical maps, viz.:—The celestial sphere, refraction, etc., the solar system, etc., comets, the seasons, day and night, and the tides, eclipses of the sun, etc., and eclipses of the moon, etc. Each series of maps is followed by an exhaustive index and descriptive letterpress. Size of the pages, 19 in. by 14½ in., several of the maps occupying two pages.

LETTS'S POPULAR COUNTY ATLAS: Being a Complete Series of Maps delineating the whole surface of England and Wales, with special and original features and a copious index of 13,000 names. (London: Mason and Payne. 1887.) Price 17s. 6d.

We have here a series of 47 maps, 17 in. by 14 in., alphabetically arranged, showing the railways and principal roads, and for the benefit of cyclists all dangerous roads are marked in red. The maps also show the Parliamentary boundaries (with number of members), Towns (with populations), Villages, Hamlets, Municipal Boroughs, Quarter Sessions, County Court, Cathedral and Post Towns, Market-Days, Distances from London and from Town to Town, and we notice also that a portion of the leading topography of the neighbouring counties is also given. At the end will be found an index of 13,000 names of places, occupying 35 pages, whereby every name mentioned may be readily found on the maps.

THE COLONIAL AND INDIAN ATLAS of the British Empire. (Edinburgh and London: W. and A. K. Johnston. 1887.) Price 7s. 6d.

Comprises in convenient form some 56 maps of the British empire (size of atlas, 11½ in. by 7 in.), of which each map generally occupies two pages. The maps are plainly engraved and neatly coloured. At the end are some interesting descriptions of the different colonies, giving an account of their area, population, imports, exports, revenue, expenditure, etc.

MANUAL OF BACTERIOLOGY. By Edgar M. Crookshank, M.B. (Lond.), F.R.M.S., Demonstrator of Physiology, King's College, London. Second edition, revised and considerably enlarged. Illustrated with coloured plates and wood engravings. Demy 8vo, pp. xxiv—439. (London: H. K. Lewis. 1887.) Price 21s.

PHOTOGRAPHY OF BACTERIA. By Edgar M. Crookshank, M.B. (Lond.), F.R.M.S. Illustrated with 86 Photographs, reproduced in autotype. Royal 8vo, pp. xx.—64. (London: H. K. Lewis. 1887.) Price 12s. 6d.

Two very valuable works on this most important subject, which we unhesitatingly state are treated in a most thorough manner. Thus we find the MANUAL first describes the Histological apparatus required in Bacteriological research, the Microscope and its accessories, and the Microtome. The various reagents and materials employed in hardening, decalcifying, embedding, fixing, and cutting of tissues; for examining and staining microscopical preparations, and for mounting and preserving preparations; apparatus for drawing and photographing; for sterilisation; for preparing and storing gelatine, etc., and for employment of nutrient jelly in test tube and plate cultivations; for the preparation of potato cultivations; of solidified sterile blood serum; for storing, and for cultivations in liquid media; and for incubation, etc.; followed by chapters on the microscopical examination of Bacteria in liquids, in cultivations on solid media, and in tissues; on the preparation and staining of tissue sections; the preparation of material; media and methods of cultivation; and experiments upon the living animal, etc. Part II. treats of the General Biology of the Bacteria, and Part III. is systematic and descriptive. In this work there are 29 beautifully coloured plates, in addition to 137 engravings in the text, many of which are coloured.

THE PHOTOGRAPHY OF BACTERIA treats mainly of the photography of the subject; chapter I. opening with a short historical sketch of the application of Photography, Micrography, the difficulties presented by stained specimens, and the reasons for resorting to Photography; chapter II. describes the apparatus and material; chapter III., the practical manipulation; and chapter IV., reproduction from negatives, etc. In addition to the very fine autotype plates, there are 6 excellent wood engravings describing the various photographic apparatus.

YEAR-BOOK of the Scientific and Learned Societies of Great Britain and Ireland. Fourth annual issue. (London: C. Griffin & Co. 1887.)

This volume comprises lists of the papers read during the year 1886 before societies engaged in fourteen departments of research, viz.:—General Science; Astronomy, Mathematics, and Physics; Chemistry and Photography; Geography, Geology, and Mineralogy; Biology, including Horticulture, Microscopy, and Anthropology; Economic Science and Statistics; Mechanical Science and Architecture; Naval and Military Science; Agriculture; Law; Literature and History; Psychology; Archæology; and Medicine, with the names of their authors. The volume contains a large amount of information as to the officers, etc., of the various societies, and in what manner their transactions are preserved.

ELEMENTARY MICROSCOPICAL TECHNOLOGY: A Manual for Students of Microscopy. In three parts. By Frank L. James, Ph.D., M.D. 8vo., pp. 106. (St. Louis, Mo., U.S.A.: *Medical and Surgical Journal* Co. 1887.)

The first part only of this work is at present published, and is entitled THE TECHNICAL HISTORY OF A SLIDE, from the crude material to the

finished mount. The writer here invites the student to witness the preparation of a typical mount, and in subsequent chapters each stage of the process is taken up in detail and in the order in which they occur in actual work. We have read this book with much interest, and find it contains much valuable information.

THE FUNGUS-HUNTER'S GUIDE and Field Memorandum Book. With analytical keys to the Orders and Genera, illustrated, and notes of important species. By W. Delisle Hay, F.R.G.S. Post 8vo, pp. 156. (London: Swan Sonnenschein and Co. 1887.) Price 3s. 6d.

The author tells us that when out fungus-hunting he has been in the habit of carrying with him a pocket-book, in which he had noted various memoranda useful for the rapid identification of anything found, and it is from these notes that the present book has grown. It contains analytical tables of the orders and genera, and many illustrations of the various species. It is interleaved with ruled writing-paper, which will be found very convenient to the student.

STUDIES IN MICROSCOPICAL SCIENCE. Edited by Arthur C. Cole, F.R.M.S. (Birmingham: J. G. Hammond and Co.)

Since our last we have received No. 9 of these very excellent Studies. Section I continues the study of Vegetable Physiology and treats of the digestive glands of carnivorous or insectivorous plants, illustrated by a vertical section through a leaf of Butterwort (*Pinguicula vulgaris*). Section II.—Animal Histology—treats of Reproduction in Lamellibranch Mollusca, illustrated by plate showing single ovarian tubule, × 100 and Portion of the lacunar parenchyma, × 400. Section III.—Pathological Histology treats of Chronic and acute Interstitial Nephritis. The plate accompanying this part shows Kidney in Leucocythæmia × 600. Part IV.—Popular studies—commences the study of Roots, Stems, Growing-points, and Leaves, and is illustrated by a double-stained vertical section of leaf of *Eucalyptus globulus*. The slides accompanying these studies are of Mr. Cole's well-known excellence.

THROUGH NORTH WALES WITH MY WIFE: An Arcadian Tour. By J. Roderick O'Flanagan, B.L. Foolscap 8vo, pp. xv.—175. Price 2s.

Here we have a very pleasant tour pleasantly described. The author tells us at the outset that he is a Roman Catholic, and as all the guide-books hitherto written have been written by Protestants, he has taken a special care to give his co-religionists accurate information, and to describe the Catholic chapels and convents in North Wales in terms which must prove interesting to them. The little book contains a good map of Carnarvonshire and Anglesea.

BIRD'S-EYE VIEW OF THE THAMES from London to Oxford. Foolscap 8vo, pp. 46, with map in 3 sections.

We have first a general sketch and description of the river Thames, its currents, locks, tide, etc., with table of distances, followed by a short description of all the places passed in the journey by river from London to Oxford. The map, which is divided into 3 sections, each about 56 inches long by 6 inches wide, is coloured, and shows not only the many serpentine bends in the river, but includes also a useful map of the country on either side of it.

TOURIST'S GUIDE and Handbook to England and Wales. By G. H. Bacon, F.R.G.S. With Atlas of England and Wales appended. Foolscap 8vo. (London: G. W. Bacon and Co.)

The counties of England are separately described on a uniform plan, as well as North and South Wales, the Lake district, the Isle of Wight, and the Isle of

Man. The descriptions of the counties are arranged alphabetically. At the end of the book is an atlas of 13 maps, and an alphabetical index containing the names of every town described in the book, etc. etc.

OUR EARTH AND ITS STORY. Five parts of this interesting work have now been received, in which we find much information respecting stratified and unstratified rocks, dykes, and mineral veins, etc., volcanoes and volcanic islands, etc.

On reading again our April reviews, we notice that we described "Our Earth" as a magazine; we intended to have said it was a work issued in monthly parts. Each part contains several good engravings and one coloured plate.

THE SIGNIFICATION AND PRINCIPLES OF ART: A Critical Essay for General Readers. Being an attempt to determine the essential nature of the fine arts, and to distinguish them from other modes of human activity. By C. H. Waterhouse. 8vo, pp. 154. (London: J. S. Virtue and Co. 1886.)

The author of the work before us, in discussing the nature of art, describes the essential principles involved in all those art productions in which the term *artistic* is applicable, and forcibly shows that there is in the nature of man and in the world in which he dwells, that which may furnish a foundation for that broad and stately monument to human genius which we call art. The author's imagination is vivid and his arguments forcible and good.

THROUGH MASAI LAND: A Journey of Exploration among the Snow-clad Volcanic Mountains of Strange Tribes of Eastern Equatorial Africa. New and revised edition. By Joseph Thompson, F.R.G.S. Crown 8vo, pp. xii.—364. (London: Sampson, Low, and Co. 1887.) Price 7s. 6d.

We have before us the narrative of the Royal Geographical Society's Expedition to Mount Keniaand Lake Victoria Nyanza in 1883—4, written in an exceedingly interesting manner. The book is nicely illustrated, and is accompanied by a good map of the route taken by the expedition.

FIFTY YEARS OF NATIONAL PROGRESS: 1837—1887. By Michael G. Mulhall, F.S.S. Post 8vo, pp. 126. (London: G. Routledge and Sons. 1887.)

A comparison of statistics, showing a very satisfactory progress in eleven out of twelve principal points of national welfare, the one point only on which a decline is shown being agriculture. The frontispiece is a diagram in red and blue, comparing the progress in population, wealth, trade, manufacture, agriculture, and instruction during the same period.

THE ANATOMY of the Brain and Spinal Cord. By J. Ryland Whitaker. 12mo, pp. xii.—135. (Edinburgh: E. and S. Livingstone. 1887.) Price 4s. 6d.

This little work embodies the series of demonstrations on the brain and spinal cord which the author has been in the habit of giving to the senior students of the Edinburgh School of Medicine, Minto House. It is nicely illustrated with 22 plates, several of which are differentially coloured.

THE PRINCIPLES AND PRACTICE OF SCHOOL HYGIENE. By Alfred Carpenter, M.D.Lond., etc. Post 8vo, pp. 368. (London: Joseph Hughes. 1887.) Price 4s. 6d.

This will be found a most useful work, and should be studied by students

training for educational work. It treats of a great variety of subjects—*e.g.*, in the first part, Drainage, Ventilation, Physical Exercise, Time allotted to Study, School Seats and Desks, etc.; and in the second, School-Surgery, with general directions as to Infectious Diseases, Wounds, Drowning, Dislocations and Fractures, Care of the Eyes, Ears, Voice, etc. The work is nicely got up and the subjects of the different paragraphs are shown in **black type** in the margin.

TAKING COLD (the cause of half our diseases): Its Nature, Causes, Prevention, and Cure. By John W. Hayward, M.D., M.R.C.S., L.S.A., etc. (London: E. Gould and Sons, 59 Moorgate St. 1887.) Price 1s. 6d.

This little book, which has now reached its 7th edition, was originally published under the conviction that, by attention to the directions it contains, persons may not only very frequently avoid taking cold, but may themselves frequently cure a cold at its onset, and thereby prevent the development of many of those serious diseases that would otherwise follow. It contains, in our opinion, a large amount of most useful information.

THE DOG-FANCIER'S FRIEND: A Handy Guide to Everyone Possessing a Dog. By G. S. Heatley, M.R.C.V.S. Crown 8vo, pp. 106. (London: Simpkin, Marshall, and Co. 1887.)

The object of the writer of this interesting little book is to inculcate humane and generous treatment towards our canine friends. The book is divided into three parts. The first consists of anecdotes, etc., of dogs; the second describes the various breeds of dogs; and the third gives directions for breeding, training, etc.

HOW TO STUDY THE ENGLISH BIBLE. By R. B. Girdlestone, M.A. Crown 8vo, pp. 112. (London: The Religious Tract Society. 1887.) Price 1s. 6d.

Much useful information is here given respecting the Bible—its language, translation, age, authority, etc., and rules for its study.

THE A B C of Modern (Dry-Plate) Photography. (The London Stereoscopic and Photographic Co.) Price 1s.

This is the 22nd edition of the useful little A B C of Photography. Each edition has seen some improvements. In the first part we find general instructions for Amateurs; and in the second, Hints on Portraiture, Retouching, Making Magic-Lantern Slides, Instantaneous Photography, Detective Cameras, and other very useful information. The Stereoscopic Company has also sent us their 144-page Catalogue of Photographic Apparatus.

THE PUPIL-TEACHER'S GEOGRAPHICAL YEAR-BOOK: First Year. Crown 8vo. (Edinburgh: W. and A. K. Johnston.)

An immense amount of information is contained in this little book. It describes the position, form, extent and area, political divisions, population, coasts, surface, river systems and lakes, climate, vegetation, animal life, government, etc. etc., of the British Isles, British North America, and Australia. There is a chapter on the physical geography of hills and rivers and a number of useful maps.

REFORMATION HEROES. By the Rev. Richard Newton, D.D. Post 8vo, pp. 192. (Edinburgh: Oliphant, Anderson, and Ferrier. 1887.)

A series of short chapters for young people, giving incidents in the lives of Wycliffe, Huss, Luther, and many others.

MOSES: HIS LIFE AND TIMES. By George Rawlinson, M.A. Post 8vo, pp. viii.—205. (London: James Nisbet and Co.) Price 2s. 6d.

This is one of the "Men of the Bible" series, and gives an interesting account of the birth, childhood, education, early manhood, and life of Moses, compiled in a great measure from the Scriptures.

THE EVOLUTION HYPOTHESIS: A Criticism of the New Cosmic Philosophy. By W. Todd Martin, M.A., D.Lit. Crown 8vo, pp. xvi.—301. (Edinburgh: James Gemmell. 1887.)

The author deals with the whole question of evolution in a very thorough and forcible manner. In chapter xv. he argues that "evolution, if true, is bound to show that all organisms *must* have sprung from the same original living matter, and to show how," and sums up the whole argument by stating that "the evolution hypothesis is incompetent to interpret the most obvious facts in nature, and is wholly illegitimate and utterly indefensible as a philosophy embracing the fundamental principles of all departments of knowledge."

SYLVAN SPRING. By Francis George Heath.—Since we noticed this interesting work in our last, parts 3, 4, and 5 have come to hand, continuing the subject to the Floral Splendour, the Ferns, and the Flowers of May. The next part will, we presume, complete the work. The engravings and coloured plates are beautifully executed.

SCHÖNBERG'S CHAIN-RULE: A Manual of Brief Commercial Arithmetic. (London: Effingham, Wilson, and Co.)

The aim of this little book is to show that the "chain-rule" might be made in England, as it has been on the Continent, to supercede many of our more complicated rules. Many examples are given, some of which prove the rule to be very expeditious, whilst in a few instances we are inclined to prefer the rules to which we have been more accustomed.

TAUNT'S ONE SHILLING MAP and Guide to the River Thames. (Oxford: H. W. Taunt and Co; London: Simpkin, Marshall, and Co.)

This map, which is divided into three sections, is on a scale of one inch to the mile, from actual surveys. The whole route is pleasantly described, a short description being given of all the towns and principal places passed. A chart is also given of distances, measured in miles, furlongs, and yards.

COOKING for an Income of £200 a Year. By Mrs. Warren. Post 8vo, pp. 175. (London: Bemrose and Sons.) Price 1s.

Some very useful hints are given in this book. A week's dinners are arranged for every month in the year, full instructions being given for cooking, etc.

RELIGION AND DUTY: Sunday Readings from Henry Ward Beecher. Selected and arranged by Rev. J. Reeves Brown.

HENRY WARD BEECHER'S LAST SERMONS preached in Plymouth Church, Brooklyn, since Mr. Beecher's return from England, October, 1886. Crown 8vo, pp. 209—308. (London: James Clarke and Co. 1887.) Price 3s. 6d. each.

The first of these works, by the late celebrated preacher, consists of 52 short chapters on a variety of religious subjects.

The sermons are 17 in number, and are written in the very forcible style for which Mr. Beecher was so famous.

CLARK'S GUIDE TO ESSAY WRITING. By Geo. E. Clark, of H.M.'s Civil Service, and W. R. J. McLean, of H.M.'s Civil Service. Crown 8vo, pp. 58. (London: Blackfriars Printing and Publishing Company.) Price 1s. 6d.

This little work is well suited for the requirements, both of Civil Service candidates and of students for school and university examinations. It explains in a clear and simple way the mode of constructing sentences and paragraphs, and how the subjects for an essay should be classified. A number of sentences containing errors of every-day occurrence are given and the corrections appended. There is no doubt this book will prove useful to the student.

SPIRIT WORKERS IN THE HOME CIRCLE: an Autobiographic Narrative of Psychic phenomena in family daily life, extending over a period of twenty years. By Morell Theobald, F.C.A. 8vo, pp. 310. (London: T. Fisher Unwin, 1887.) Price 10s. 6d.

This is, we think, without exception, the most extraordinary work we have ever read. The author assures us that it is true. Perhaps we are sceptical; certainly no such experiences as those related have ever been ours—*e.g.*, the author states that in 1884 it was a daily occurring event for the first member of the household on coming downstairs to find the kitchen fire "lit," the kettle boiling, and tea freshly made in the tea-pot on the table, although none of these things were left in the same room when retiring at night. After reading the entire book most carefully, we can only say such things are too wonderful for us, and we fear we are sceptics still. The book is very nicely got up.

The following books have also been received:—

SURPASSING FABLE; or, Glimpses of our Future Home. By the Rev. R. Hardy Brenan, M.A. 12mo, pp. 149. (London: James Nisbet and Co. 1887.)

HOW THE FRENCH CONQUERED BRITAIN IN 1888 and the Battles and Events which led to it. From the German of Spiridion Gopcevic (Der Grosse seekrieg im Jahre, 1886). Internationale Revue über die Gesammten Armeen und Flotten, July, August, September, 1886. Translated by Commander F. H. E. Crome, R.N. (Portsmouth: Griffin and Co.; London: Simpkin, Marshall, and Co. 1887.) Price 1s.

THE NEW PILGRIMS' PROGRESS. By Mark Twain; with an introduction by the Rev. Hugh Reginald Haweis, M.A. (Routledge's World Library.) (London: Routledge and Son. 1887.) Price 3d.

THE WORKS OF WILLIAM SHAKESPEARE. Edited by Charles Knight. (London: George Routledge and Sons. 1887.) Price 1s.

THE LIFE OF HER MAJESTY QUEEN VICTORIA, compiled from all available sources. By G. Barnett-Smith. People's edition. (London: G. Routledge and Sons. 1887.) Price 1s.

LONDON IN 1887: Illustrated by 18 Birds'-Eye Views of the Principal Streets. By Herbert Fry. (London: W. H. Allen and Co. 1887.) Price 2s.

THE TWO CROSSES. By J. W. Nicholas.

THE LOVELY WANG. By the Hon. Lewis Wingfield.

PATTY'S PARTNER. By Jean Middlemas.

V.R.: A Comedy of Errors. By Edward Rose.

Four volumes of Arrowsmith's Bristol Library. Price 1s. each.

THE JOURNAL OF MICROSCOPY
AND
NATURAL SCIENCE:
THE JOURNAL OF
THE POSTAL MICROSCOPICAL SOCIETY.

OCTOBER, 1887.

Linaria Cymbalaria.

By R. H. Moore.

Plates 21, 22, 23.

THIS charming little wild plant is, in the botanical world, one of Nature's most prolific gifts. It is so small that busy men pass it by unheeded, although perhaps unconsciously their eyes are often soothed and pleased by its picturesque beauty. Many an ugly corner and staring wall is relieved by its dark-green leaves and trailing branches. It festoons the ruined arch and wreathes the bare stones with its luxuriant tapestry of foliage, through which, at numerous points, its pale but pretty purple flowers struggle into sunshine.

It is a native of Italy; but having been introduced into England, it seems—in certain localities at least—to flourish anywhere

and everywhere. Popular opinion endorses this statement, for it has given this plant the names of "Roving Sailor" and "Mother of Thousands." Nature, with her myriad forms of created things, woos us to her teaching. She daily unfolds her vast lesson-book to all who will observe. Nothing has been made in vain. It cannot, therefore, be a trivial occupation, for a little while at least, to study one of our simple wild flowers.

Artists have delighted in our wild flowers, and so, according to Ruskin, Bellini, the great Italian painter, who, with his brother, is believed to have been the founder of the Venetian school of painting, filled the creviced walls of his pictures with large bunches of the *Linaria cymbalaria*, known in Italy by the name of *Erbadella Madonna*. My task, however, just now, lies not in the realms of poetry or painting, but it is my duty to lay before you a monograph of this little plant. I have the misfortune to write upon a subject about which nothing of any importance has already been written, and I have searched in vain all the catalogues of microscopical slides for illustrations. In my researches, however, I continually met with this pretty *Linaria* "creeping over the grey wall of the ruin," as Anne Pratt writes, "and hanging down its threadlike branches from the ancient church-tower, where it fixes its roots in the smallest crevices, its rich, thick, green leaves and numerous blossoms forming a handsome tapestry with which to hide the decay of the building." Its simple beauty charmed me.

The *Linaria cymbalaria*, or "Ivy-Leaf Toad-Flax" (Pl. XXI., Fig. 1), belongs, in the natural system, to the large class of exogenous plants, sub-class *Corolliflorœ*, its flowers containing both calyx and corolla, the latter being monopetalous and personate. It further belongs to the order *Scrophularaceœ*, its petals and calyx having five irregular divisions. Its carpels are united into a superior two-celled, many-seeded pistil.

In the artificial system, its old generic name of *Linaria* was abandoned, and, in Withering's "Botany," it is to be found under the class *Didynamia* (two long and two short stamens), order *Angiospermia* (having a closed seed-vessel), genus *Antirrhinum*, species *Cymbalaria*, so that, in this system, it must be looked for in the family of the snapdragons, although, unlike them, its corolla possesses a spur.

Blossom and Fruit.—In considering the corolla, I am at a disadvantage. I have searched every locality known to me in Bath, but not a single flower can I find. The winter's frosts have interfered with their production, although in some seasons they bloom all the year through. I therefore must depend upon slides and drawings for the illustration of this part of my paper. To all superficial observers, the whole plant is insignificant. The vast majority, therefore, of "the people" pass by the old walls festooned with its graceful foliage, and never notice the exceeding beauty of its floral structure. The blossom is almost identical in shape with the corolla of the Garden or Wild Snapdragon, gaping, bulging at the base and its throat, furnished with thickly-set hairs. It has, however, a distinct spur or nectary, which is wanting in the flowers of the ordinary Snapdragons (Fig. 2, *a*, *b*, *c*). The lips of the corolla are closely set, and we must use needle and scalpel in order to lay bare the palate of the tiny flower, if we wish to enjoy its greatest charm. This consists in the beautiful orange-coloured and silvery hairs which lie thickly together within the lips. The yellow hairs lie closely together in rows, as seen in Fig. 3. Of course, they will be of much greater beauty if the palate of a fresh corolla be laid open, and then examined under the microscope. The hairs under a high power have a peculiarly marked surface; the margins of them appear to have very fine inequalities or serratures, and these, I think, are due to exceedingly minute protuberances which are scattered over their surfaces. They are larger at the apex than at the base, and I append a drawing (Fig. 4) of the corolla hairs as they appear when magnified 300 diameters.

Let me now proceed to describe the Organs of Fructification. These occupy a position within the corolla immediately opposite to the hairs just described. Since the researches of Mr. Darwin in relation to insects and plant fertilisation have been made known, and especially since the publication of Sir John Lubbock's interesting book, entitled "British Wild Flowers considered in relation to Insects," the most important question in relation to wild flowers is:—Are they fertilised by the agency of wind or insects, or are they capable of self-fertilisation? To this particular plant, I cannot find that Sir John Lubbock makes any allu-

sion. He does, however, refer to *Linaria vulgaris*, the common yellow Toad-Flax, a larger and more showy plant than the one now under consideration. He writes:—"Its flowers form a closed box, terminating behind in a spur ten to thirteen millimetres in length, which contains the honey, and the orifice of which is protected by hairs. Under these circumstances, the long-lipped bees are the only insects which can suck the honey." He further writes:—"The Snapdragon differs in the larger size of the flowers, the greater firmness with which they are closed, and in the position of the honey, which lies at the basis of the corolla, and does not penetrate into the short spur, which is hairy, and therefore not suited for such a purpose. They are almost always fertilised by humble bees, though smaller bees occasionally force their way into them."

From Sir John Lubbock we learn that many of our wild flowers are proterandrous (the anthers shed their pollen before the stigmatic surfaces of the pistils have matured). Others are proterogynous, the pistils having matured before the anthers have ripened. Such flowers entirely depend upon the visits of insects to fertilise them. The ripe pollen of the one flower *must* be carried to the mature stigma of the other, and failing this the plants will become extinct. It frequently happens, however, that the flowers are hermaphrodite, a portion of the stamens ripening before the stigma, but the remainder ripening concurrently with it, so that such flowers are first exclusively male, then male and female. Or, the pistil may mature before the stamens, when the flowers will at first be exclusively female, but as the stigmatic surface of the pistil retains its ripened character until the stamens shed their pollen, these flowers also become hermaphrodite. It may be, of course, that insect agency is at work even here, but were it otherwise, there is an abundant means for self-fertilisation.

The general principle laid down by Sir John Lubbock with reference to the fertilisation of flowers is, that large, bright-coloured, sweetly-scented, honey-yielding blossoms are largely fertilised, and the species preserved by the visits of insects attracted to them; while, on the other hand, small, scentless, honeyless flowers are less dependent upon bees and other insects because they possess ample means for self-fertilisation. Now, the *Linaria*

cymbalaria is exceedingly small as to its floral development, its petals are not highly coloured, its flowers are not fragrant, and although the corolla has certain lines upon it which may be taken as honey-guides, it is questionable if the flower contains any honey ; but on this latter point I cannot speak authoritatively. During the late summer and autumn, I frequently observed its habits and carried home specimens for study ; but while collecting these tiny flowers I have never disturbed any insects engaged upon them. I am pretty well satisfied, from frequent observation, that the blossom of this *Linaria* is homogamous—a term used to denote those flowers in which anthers and pistil ripen concurrently. I have spent a considerable amount of time in examining the parts of fructification beneath the microscope, and although, from the minute size of the pistil, it is difficult to cut sections of the necessary thinness to observe the growth of the pollen-tubes, I have frequently seen in the same flower the ripened pollen-grains adhering to the stigmatic surface of the pistil, and on one occasion I believe that a pollen-tube was detected. Again, when we consider the close contiguity of the small corolla lips, and remember how nearly every space within them must be occupied with hairs, pistil, and stamens, it is difficult to suppose that the proboscis of any insect could penetrate through such obstacles to the spur or even to the base of the corolla in search of honey, even if honey were to be found therein. I have also another reason to give against a system of cross-fertilisation.

There is a variety of *Linaria cymbalaria*, with a purely white corolla, which possesses the same kind of throat-hairs. I found it in Bath in only one locality, and only two or three plants on the spot. I took the roots away three years ago, and I have never seen this white variety since, there or elsewhere, although the wall from which I gathered it is festooned with thousands of plants with *purple* blossoms. If insects visited these flowers, the pollen would be crossed, and in such case I presume the white variety would have rapidly increased. I may add that, while exhibiting this *Linaria* at the Bristol soirée, a visitor told me that the white variety was very common in the Bristol neighbourhood. For the reasons above stated, I conclude that *Linaria cymbalaria* is entirely self-fertilised.

Fig. 5 is a drawing of the reproductive organs, and I must remark upon the beautiful character of the unripened germen. In its fresh condition it is of a rich claret colour, softly fading to a bright pink tint towards the summit of the pistil. The latter has upon its surface small papillæ-like organs, which probably aid in receiving the pollen. The latter is very abundant, the anthers being laden with its silvery granules. From the drawing the stigmatic surface of the pistil appears to be button- or knob-shaped, but if the pollen which adheres to it in such quantity be brushed away, the summit of the pistil is found to be but slightly enlarged. The drawing also does not give the true shape of the anthers, for, although it was copied from a fresh flower-section, the anthers are drawn in their usual position face to face. I have, therefore, added another drawing (Fig. 6), to show the exact shape of the several reproductive organs and a highly-magnified view of the pollen-grains. There is no particular beauty in the latter—no valves or sculptured surfaces. The pollen is rather difficult to examine because of its minute character; some of the grains appear as if a slit extended over their surfaces. When moistened, the shape becomes orbicular, and in what I suppose to be a side view there appears to be a belt surrounding each grain.

In the drawing (Fig. 6, *d*) they are magnified 300 diameters; the actual measurement of each grain is about the $^1/_{500th}$ part of an inch. I spent an evening in the treatment of the pollen with acids, etc., with the result shown in the drawing. The tubes appeared almost instantly on the application of spirit. In glycerine, only two appeared in the space of about forty-eight hours. I was not able to detect any particular orifice from which the tube lengthened. It appeared to issue from any portion of the outer membrane, and the rupture was attended with a violent jerk of the pollen-grain.

I now proceed to notice the seed-capsule and its contents. It has been already remarked that the natural habit of the plant is to grow in the crevices of old walls. It seems to flourish here in such positions, although it freely grows upon the summits of old walls. When springing from a perpendicular wall, it hangs in long festoons, and some provision is therefore necessary to secure the ripened seed from being scattered upon the ground at its base, to

be trodden under foot. Nature has wonderfully provided against such a contingency. The Psalmist exclaimed, "O Lord, how manifold are Thy works; in wisdom hast Thou made them all." In this tiny, unobserved plant, a proof of creative wisdom is readily seen. A careful observer will notice that as the blossom of *Linaria cymbalaria* fades and the seed-capsule swells, its long green stalk gradually turns inward. When the capsule is ripe, its position is exactly the opposite to that formerly held by the flower. The latter stole out from the thick green leaves into sunshine, but the former retires to the rear of the pretty tapestry until the seed-vessel is close to the crevices of the wall ready to discharge its precious freight. Some observers have gone so far as to credit this little plant with a kind of instinct to preserve its species. Miss Pratt, in her "Flowering Plants of Great Britain," writes:—"The capsules, before ripening, turn towards the wall on which the plant so often grows and *place themselves in a crevice or hole*, so as to shed the seeds, when ripened, in a place where they may thrive, instead of scattering them on the ground where they would be wasted."

A correspondent to *Science Gossip*, in the September number, 1867, p. 211, writes:—"The seed-vessel faces the wall. But this is not sufficient. The office of the pedicle is not accomplished until its precious burden is placed in safety. For this purpose it draws close to the face of the wall or building, and then actually seems *to search out a rough chink or hollow, into which it may thrust its capsule*, in order that the seeds may find a secure resting-place when separated from the parent plant."

This curious and wonderful habit was denied to the plant by a subsequent writer in *Science Gossip*, but observers may witness to the correctness of the statement, in greater part at least, in any of the localities where it thrives. No explanation of this peculiar but important function has been offered so far as I have gleaned; but I shall presume to offer one, leaving my readers to judge of its probable correctness. In dissecting the flower-stalk, one is impressed with its tough and wiry nature. When the outer membrane, which is readily detached in a cylindrical form, is removed, the interior stem appears as a white, thread-like substance, very strong and slightly elastic. If this be macerated in water and

roughly compressed, it is found to consist of bundles of spiral fibre. So closely are these fibres wound together, that from ordinary observation the bundles of tissue appear to be merely pitted, but closer observation will reveal that this fibre is truly spiral, and if sufficient pressure is used, it may be detected in an unwound condition. I think, therefore, that in the unripened seed-stem this spiral tissue is at its greatest elasticity. As the capsule ripens, the spiral fibre contracts and causes the stem of the capsule to curl and twist, owing to the non-contraction of the outer cuticles, and thus the object of seed-preservation is attained.

The capsule has two divisions, each of which contains 15 or 17 seeds. I have counted as many as 41 in some fine specimens of plants obtained in this locality. From the drawing, Fig. 7 (which is magnified 40 diameters), the size and shape of the seeds may be readily seen. The wrinkled nature of the seeds renders them easy for lodgment in the wall-crevices; the irregularity of their surfaces prevents them from rolling out of their home in the upright walls. They are not at all unlike miniature walnut-kernels. When fully ripe, they are of a rich brown colour; if not quite ripe, of a reddish tinge. A section of these minute seeds reveals the true colour of the testa and its pretty cellular formation. Their small size renders dissection difficult, and I have been unable to detect the character of the substance which is interposed between the embryo and the seed-coat. I presume it is the usual albuminous matter, but the sections I have mounted show the walls of the testa and the interior cellular mass, and forms a beautiful object under polarised light (Fig. 8). On a blue selenite ground, the cell-walls are very distinct in red and green, and colourless granules occupy the minute spaces. The embryo is very large, and with careful focussing it is seen to possess two cotyledons, reclinate—*i.e.*, folded from apex to base. I have spent some time in watching the germination of the seeds, having sown them in damp sand, but for several weeks they gave no appearance of life. Ultimately, however, I obtained a fine crop of young *Linaria*, and there are two reasons for especial remarks. First, the leaves and stems of the seedlings were studded with very minute capitate hairs, which are not found in the perfect plant; second, the under-surfaces of the miniature leaves were

invariably of the purple colour which characterise so many of the leaves of the full-grown plant.

Passing on to the characters of leaves, roots, and plant-stems, I will shortly call attention to their several structures.

The Leaves of the fully-grown plant are quinquangular in shape, seated on very long foot-stalks. The upper surface is of a dark, shining, green colour; the under surface of a metallic grey. I have already remarked upon the purple tint of the under surface of many of the leaves. The cause of this peculiarity was sought for unsuccessfully by a correspondent to *Science Gossip* four or five years ago. He suggested that probably some change takes place in the chlorophyll of the cells. This is hardly satisfactory, as the purple tint is not, as it is in so many plants, the sign of approaching decay. The beautiful colour is very abundant in the leaves of the seedlings, so that the tint is due to colouring matter similar to that which imparts beauty to the petals of our garden and greenhouse flowers. The variety in colour of these leaves adds elegance to the tiny *Linaria*. The blossom is small and not deeply tinted; consequently, it would not attract very great attention. But when from among the bright green leaves many of them curl and exhibit their purple and almost crimson under surfaces, the attractive qualities of this little plant are considerably enhanced.

The Cuticle of the leaves is well worthy of consideration. The upper cuticle is detached with very great difficulty, and I have not been able to obtain good specimens, although the leaves have been boiled in diluted acid. It contains no stomata, and the cells are of an ordinary shape. The under cuticle is one of the most beautiful of its kind. It is a tough membrane, readily detached, with large cells of sinuose character; they appear to contain but a small quantity of chlorophyll. This cuticle becomes too transparent for observation when mounted in balsam, and therefore must be stained before mounting.

The Stomata are confined to the under cuticle, and they vary in point of numbers in different plants and in different portions of the same leaf. I have paid a little attention to their frequency, and from one specimen I calculated that a square inch of surface would contain about 1079 stomata. They are exceedingly minute, and possess the usual kidney-cells around the fissures of the

organs. The figures 9, 10, and 11, were drawn by the aid of the neutral-tint reflector. In sections of the leaves mounted in balsam, the interior cells are readily seen. The upper cuticle covers the usual perpendicular cells, filled with dense masses of chlorophyll ; the under cuticle encloses cells comparatively free from this deposit, and although the stomata are indistinct, the air-cells in connection with them are easily traced. I cannot detect starch-grains or crystals, but as these sections polarise well, they may probably contain both.

I have already entered somewhat fully into particulars of the component parts of the flower-stem of this *Linaria*, but I will dwell for a moment upon the PLANT-STEM. It consists of an outer cuticle, highly coloured by the matter formed within its large transparent cells, and contains but little chlorophyll. The inner cuticle or membrane is composed of denser cells, with an abundance of green matter. The interior portion is composed of a central medulla or pith, a cellular formation of larger cells than in other parts of the stem, and giving in a transverse section the characteristic of a hollow stem. Immediately surrounding the pith comes the medullary sheath of spiral vessels ; then a zone of denser cells, surrounded by a mass of larger cellular tissue, while the cuticle encloses all.

THE ROOTS of this little plant are remarkable for their clinging powers. This is not to be wondered at when we consider the position which the whole plant occupies on perpendicular walls. It has the means, by its fibrous roots, to adhere to its otherwise precarious lodging.

In conclusion, let me remark on the desirability of making common objects our study. Take any object you please, and endeavour to bring it into monographic description, and you will have an interesting subject of investigation. This little *Linaria*, as I gaze upon its festoons, reminds me of many happy hours spent in its cheerful company, and we shall ever be familiar friends. Sir John Lubbock, in closing one of his books, writes :—" Few, I believe, of those who are not specially devoted to zoology and botany have any idea how much still remains to be ascertained with reference to even the commonest and most abundant species."

[The above paper and accompanying drawings were circulated with a box of slides round the Postal Microscopical Society during the years 1882—3; therefore, by way of addenda to the paper, we think it well to add some of the notes which were written by members in further description of this interesting little plant.—*Editor.*]

ADDENDA.

I would suggest that the slide of hairs of the corolla should also have been mounted in balsam, so as to admit of polarisation.

E. E. JARRETT.

It is really wonderful how this plant adapts itself to its environment. I have grown a plant of *Linaria cymbalaria* in an enclosed glass porch, and have been surprised to find here and there a small plant springing into existence, showing into what minute and dry crevices the seeds find their way, and at considerable distance from the parent plant, and where they are utterly devoid of water.

J. H. WILSON.

It is to be hoped that the confession made by Mr. Moore, p. 197, that he has never come across a specimen with the white corolla since taking away the whole of the plants with their roots, may lead some collector to be more merciful than they sometimes are when they come across a rare specimen. Let them, at least, leave the root.

JAMES C. CHRISTIE.

We are told on p. 201 that there are no stomata on the upper cuticle. I think another examination would show several large and well-defined stomata there.

W. SWALLOW.

There is one point respecting the presence of stomata on the upper side of the leaf, which appears to have been overlooked by Mr. Moore on p. 201. Although very much fewer in numbers than on the underside, they exist, as remarked by Mr. Swallow, and I also find that the outline of the cells of the upper cuticle is somewhat like that of the cells of the under cuticle—viz., more or less sinuous or wavy, not so markedly so as on the under side, but much more so than is shown in Fig. 9.

GEO. D. BROWN.

Not the least valuable of Mr. Moore's observations are those bearing on the structure of the stalk of the seed-vessels. I think there is little doubt that his explanation of the peculiar behaviour

of the stalk during the ripening of the seed is correctly stated as being dependent on the contraction of the spiral tissue. I would suggest that the lodgment of the seed in the small crevices may be explained without crediting the plant with any discriminative power. To do this would, of course, be absurd; but I think a rational explanation is easy. Suppose the mature seed-vessel to be, by the action of the contractile fibre, brought into contact with the wall at the same time that, by the continued contraction of the stem-fibre, producing a certain relation of the seed-pod, the latter was scraped against the surface of the wall. This would, no doubt, end by its travels being eventually stopped by a hole or crevice, in which the seed would in all probability germinate.

W. LEICESTER GREVILLE.

I quite agree with Mr. Moore's closing remarks, and his quotation from Sir John Lubbock, as to the desirability of turning one's attention to the thorough study of one or two of the commonest objects to be found in one's own immediate neighbourhood. Such objects are sure to present points of interest, little or not at all elucidated, and much good work may be done.

ARTHUR HAMMOND.

EXPLANATION OF PLATES XXI., XXII., XXIII.

Fig. 1.—*Linaria cymbalaria*, natural size, from a Nature-printed drawing.

,, 2.—Corolla. *a*, side view, closed; *b*, side view, open; *c*, front view, showing the five clefts as numbered 1—5, all × 5 diam.

,, 3.—Hairs *in situ*, within corolla, × 48 diam.

,, 4.—Ditto, × 300 diam.

,, 5.—Germen, pistil, stamens, and pollen, × 11 diam.

,, 6.—*a*, Calyx and pistil, × 15 diam.
b, Long stamen, × 15 diam.
c, Short stamen, × 15 diam.
d, Pollen, × 300 diam.
e, Do., in glycerine.
f, Do., in acetic acid.
g, Do., in spirit, showing pollen-tubes.

,, 7.—Seeds, × 40 diam.

,, 8.—Section of seed, × 65 diam.
a, testa; *b*, endosperm; *c*, embryo.

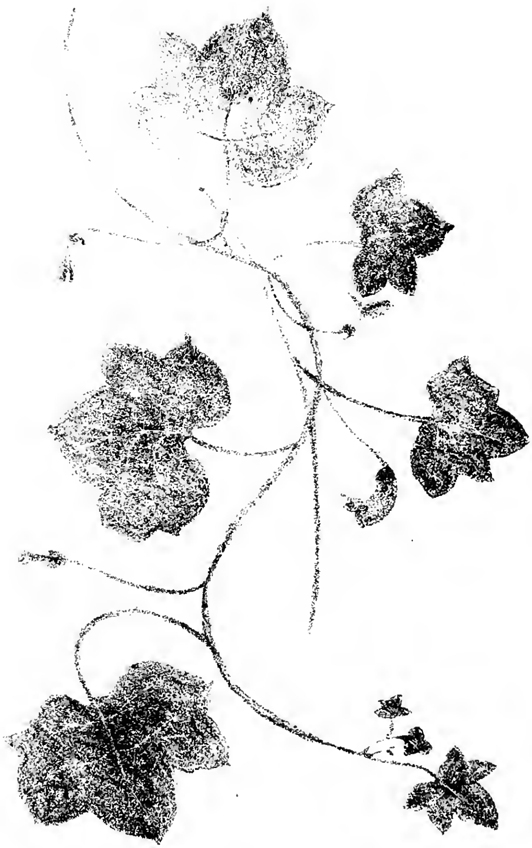
,, 9.—Cells of upper cuticle of leaf, × 40 diam.

,, 10.—Cells of under cuticle, with stomata, × 70 diam.

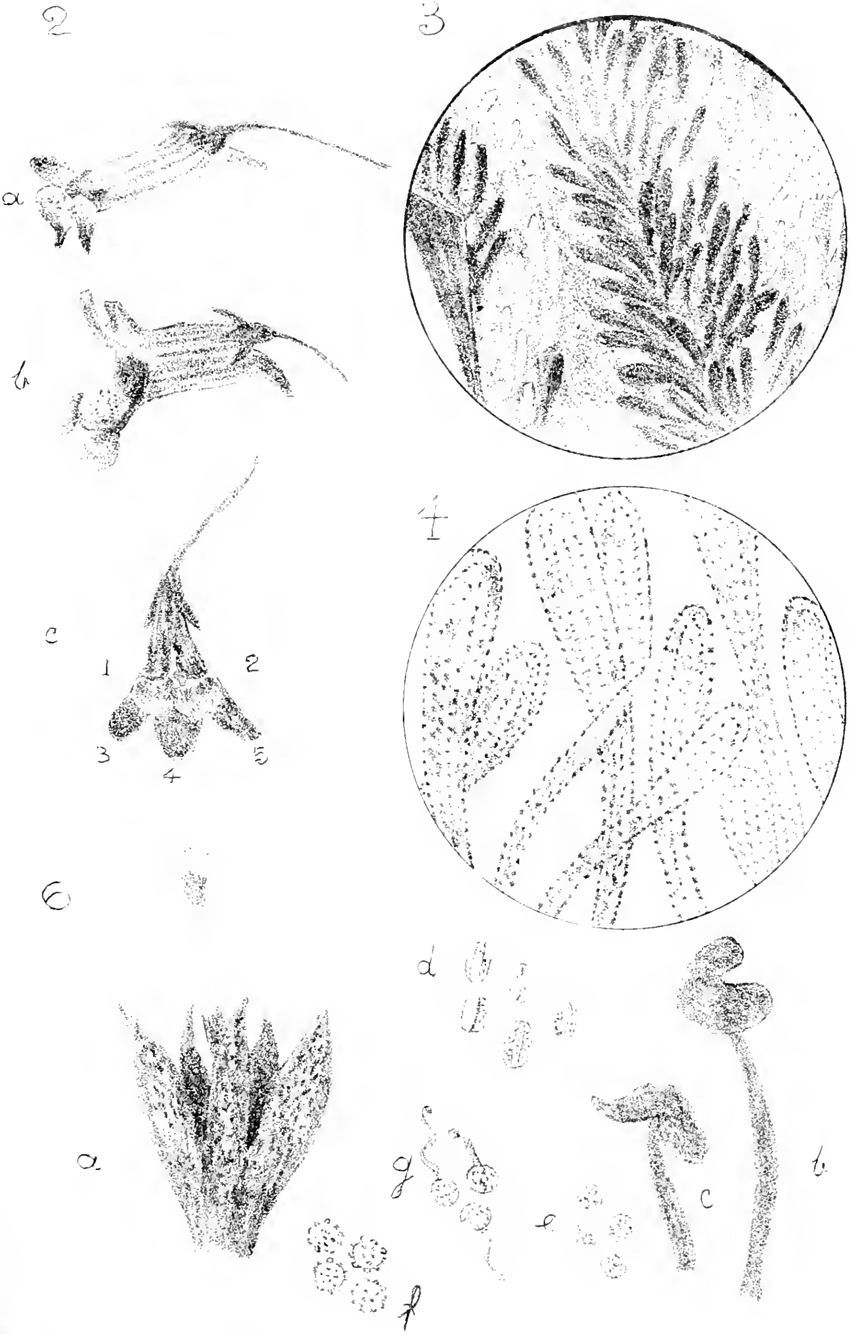
,, 11.—Under cuticle, with stomata, × 250 diam.

Drawn by R. H. Moore.

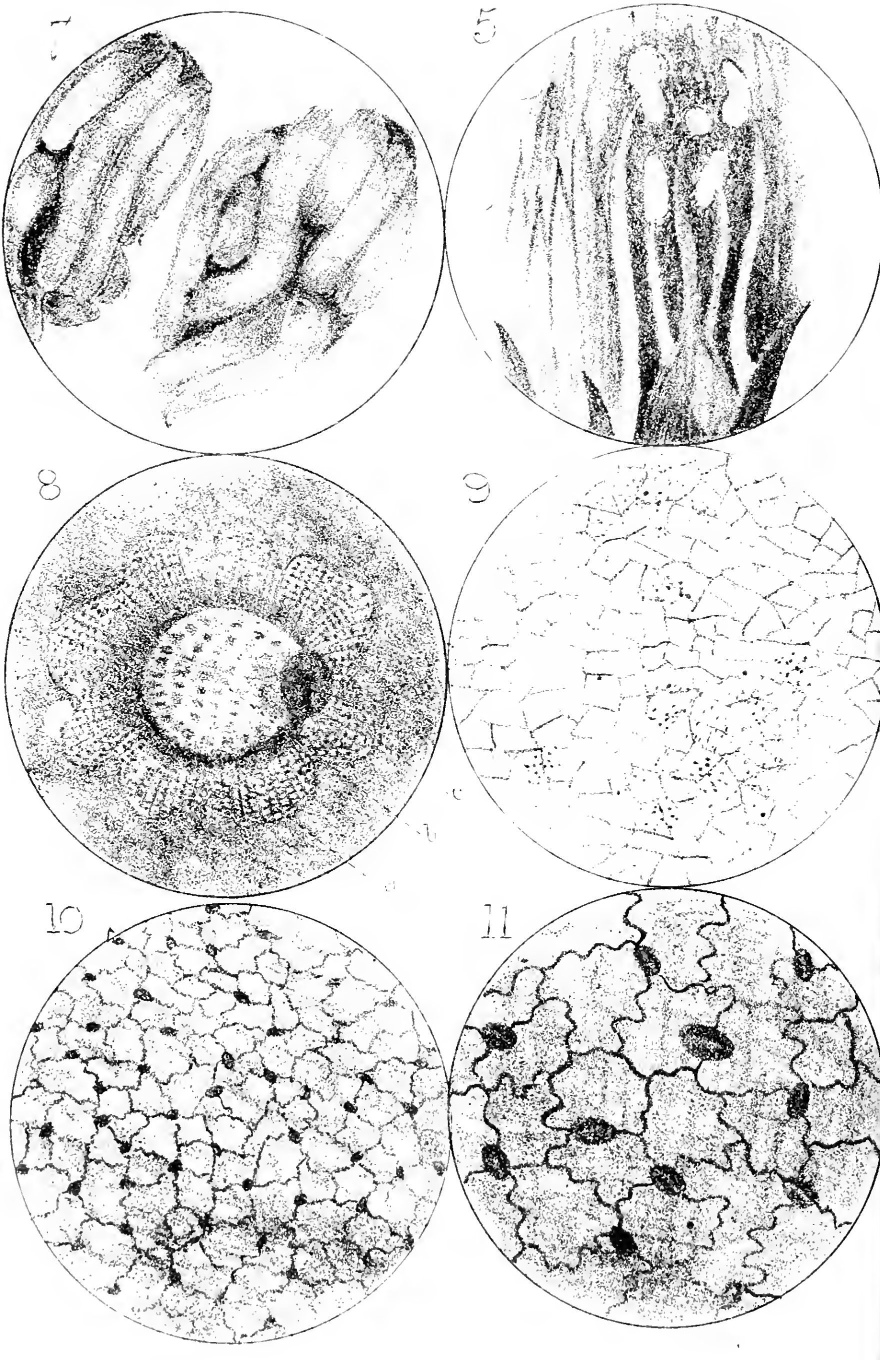
1



Linaria cymbalaria.



Linaria cymbalaria


7
5
8
9
10
11

The Photo-Micrography of Histological Subjects.*

By Y. May King, M.D., Amoy, China.

THE idea of utilising photography as a means of recording scientific investigations with the microscope presents so many attractions that it undoubtedly has occurred to many microscopists. But as yet comparatively few appear to have availed themselves of this method of obtaining an indisputably exact reproduction of what is shown by the microscope. And even these few have given their chief attention to diatoms, of which they have made very beautiful micro-photographs. Practical pathologists, as a rule, I think, have been deterred from attempting to use photography by the mistaken apprehension that the process was too long and wearisome for one with but little spare time, and also that the results to be obtained in the case of histological subjects would not sufficiently recompense for the labour bestowed. But in reality it is not any more tedious, nor does it require any more time, to make a photo-micrograph than it does to make a photograph of any other kind. There is no reason why an objective which will project a clear image upon the eye will not do the same upon a sensitive plate, nor why such impressions should not be treated like the impressions from other kinds of lines. The measure of success I have met with in the photo-micrography of histological subjects, while pursuing it for my own benefit as a welcome alternative to camera-lucida drawing, has induced some of my friends to suggest that I might, perhaps, be able to give some practical hints which would be useful to others, toiling over camera-lucida reflections, who would like to experiment in this interesting branch of photography.

It does not require a great amount of skill, nor is it nearly as laborious as drawing, and, I think, will be found far more satisfactory in the end.

I would here acknowledge my great indebtedness to Professor T. W. Smillie, chief of the photographic department of the

* From the *New York Medical Journal.*

National Museum in Washington, D. C., for valuable advice and instruction, which his rare comprehension of the difficulties to be overcome enabled him to give me, and for the facilities afforded me in the laboratory under his charge.

The limits of this paper will not permit of my describing minutely the details which belong to ordinary photography, and so many are already accustomed to the treatment of usual subjects that it would be needless to do so. I shall therefore only endeavour to indicate the points of special interest and the necessary apparatus.

For those practically unacquainted with photography, I would suggest that a few lessons from a professional photographer will be of immense value, saving much time and mental perturbation in ascertaining the best manner of working.

The necessary parts of the apparatus are not numerous, and need be but very simple. They consist of a microscope, a light, a condensing lens, a photographic camera with a plate-holder, plates and a few chemicals, and a room to work in. The microscope should have good objectives, for they will be subjected to a very severe trial, and the most judicious treatment fails to get good results with poor objectives. The qualities specially desirable are achromatism, good definition, penetration, and a flat field. The two latter have been the most difficult to obtain, in my experience. The penetration may be improved by inserting a diaphragm behind the posterior combination of the objective at the point of the greatest convergence of the rays. This point is most easily ascertained by sliding the diaphragm up and down until the proper spot is reached. The use of a diaphragm diminishes the amount of light; but, with low powers where the greatest penetration is necessary, the amount of light admitted into the objective is so large that this loss is of no consequence. It would, doubtless, be convenient to have apochromatic glass; but the difference between the chemical and visual foci may be remedied by the use of a blue cell. In working without an eye-piece, the objective should be screwed to the end of a short, wide tube—say, about six inches long and two inches wide, well blackened in its interior.

As to the relative merits of working with or without an eye-

piece, I am not now prepared to speak; most of my work has been done without one. The eye-piece has, or should have, the merit of rendering the field aplanatic.

For light, kerosene lamps, such as are used with magic-lanterns, etc., furnish sufficient for low powers, if the object presents strong contrasts and sharp outlines, so that the definition is not taxed too much. The flat wicks are preferable, although a round one answers pretty well. With high powers, or where fine definition of delicate details is needed, the oil-lamp is not sufficient, and a stronger light must be used—such as an arc electric light, or sunlight. The strong, clear, white light of these two gives the best definition, and also enables one to focus much more accurately. Sunlight I have found all that could be desired. It is the most available for general use, and in the United States National Museum, after many trials of various other kinds of light, it is considered the best for photo-micrographic purposes. The only apparatus necessary in using it is a heliostat to reflect the rays upon a condenser. The condensing lens should be about three inches in diameter, and should have a focal length of from six to eight inches. A slight variation in the size of the condenser makes no material difference, provided it is not too convex, as the rays entering the objective should be as nearly parallel as possible, in order to secure more accurate definition.

A substage condenser is not necessary for tissue photography, except with very high powers. The size of the camera may be left to individual choice. In the National Museum the one which I used was suited for an eight-by-ten plate, and had a bellows arrangement five feet long. If the eye-piece is used, two feet of bellows will be sufficient. The plate-holder should be capable of carrying a collodion plate, and also be provided with mats for holding smaller sizes, if an eight-by-ten plate is generally used.

If sunlight is used, the work-room should have one window facing the south, the lower sash replaced by wooden shutters and the upper one supplied with orange-coloured glass, and a thick roller shade, by means of which the room may be darkened while an exposure is being made, so that no actinic light will enter the objective except that which passes through the condenser.

The different parts of the apparatus are conveniently arranged

and secured upon a stout, smooth board, resting on a firm table near the window. Fasten the camera-bed to one end of the board. In front of it place the microscope screwed upon a block of sufficient height to bring the tube opposite to the centre of the camera-lens aperture. leaving a few inches of space intervening, in order to permit of focussing the objective up and down, or rather backward and forward, as the microscope tube is now horizontal. The intervening space referred to may be bridged over by a sleeve of black velvet, or anything pliable, which is at the same time opaque and has a non-reflecting surface. The wrist end of a lady's black undressed kid *mousquetaire* glove, turned wrong side out, will answer very well by tacking the larger end around the camera-lens aperture, and securing the other end around the tube by means of an elastic band.

Next comes the condenser, which must be fastened to the end of a tube which slides smoothly in a collar fitted around a hole cut in the window shutter. By this arrangement the condenser may be moved back or forth as circumstances require without throwing it out of line. The position of the hole should be carefully regulated, so that the optical axis of the condenser will be in the same line with the optical axis of the objective.

The heliostat is placed outside of the window, either on a separate shelf or on the end of the same board which carries the rest of the apparatus, in which case the shutter with the condenser must be notched at the bottom to fit over the board, and lifted out while it is being pushed out of the window to a sufficient distance. When once regulated for the latitude and the time of day, the heliostat moves by clockwork and requires no further attention.

If artificial light is used, it should be enclosed in something to prevent the rays from being diffused in the room. [When using my kerosene lamp, I had a piece of stove-pipe in which a hole had been cut opposite the flame for inserting the tube of the condenser.] Having arranged all carefully in line, adjust the condenser so that its focus will pretty nearly coincide with the focus of the objective, or until the cone of light upon the object and the field of the objective are of about the same size, and test the apparatus with some slide requiring fine definition and a low power. Focus down with the coarse adjustment until the usual working distance

is reached. Slide the bellows back and forth until the image is vaguely seen upon the ground glass, and then use the fine adjustment until the image is perfect. It may be necessary to throw a focussing cloth over the head and camera, in order to see the fine details clearly.

Sometimes one or more bright spots appear in the field, interfering greatly with the definition. These are due to reflections within the objective, or in some other part. By taking away the ground glass and looking in with eyes almost shut, so as not to be dazzled, one may generally detect where the reflections occur. Sometimes the sleeve is not light-proof, or has become detached and admits stray beams of light, which make confusion. When the eye-piece is used, the objective may be focussed as usual, and the stand bent horizontally. Then slip the sleeve over the end of the tube, being careful not to disturb the adjustment; and focus the image upon the ground glass by moving the bellows.

A more trying difficulty is curvature of the field. This increases with the higher powers, so that often, out of a field five inches in diameter upon the ground glass, not more than half-an-inch can be brought into focus at one time.

The best general effect is obtained by selecting some point to focus upon, midway between the centre and the periphery. This gives a field with moderately good definition throughout, and no great contrasts between well-defined and blurred lines.

If there is any special detail to be demonstrated, that of course must be placed in the centre of the field and focussed without regard to the rest. As objectives are now constructed, the only remedy that I am aware of is to make use of an eye-piece or amplifier suited to the particular objective used.

Lack of penetration may be somewhat obviated by a diaphragm, as I have said before. The difference between the chemical and visual foci is ascertained by interposing between the stage and the condenser a deep violet-coloured solution (about 8 per cent.) of pure cupric oxide in ammonia. If the cell is made of glass strips, this fluid, which is exceedingly corrosive, soon acts upon the cement and destroys it. When not in use, it is advisable to pour the solution out, unless it is contained in a brown glass cell, such as is used for holding fluid in spectrum analysis.

This blue medium practically stops all except the violet rays, and leaves only the chemical focus. If now the image is as well defined as before, the two foci are coincident; if not, the distance which the objective must be moved, to restore the definition, is equal to the difference. In low powers this is apt to be marked. With good modern objectives, the higher powers do not generally present any difference.

Often a dark edge appears. or the field is lighter in one part than another. This is due to the heliostat being out of proper relation to the condenser, so that it is not uniformly illuminated. Unless this is corrected, the negative will not be of uniform density. When all is satisfactory upon the ground glass, a sensitive plate may be substituted and the exposure made by intercepting the light between the condenser and the stage with a bit of blackened cardboard, while the slide is being drawn out; then lifting the cardboard for the necessary time, then replacing it while the slide is being drawn back. If the exposure should occupy several minutes, the cardboard will not be necessary, since the time taken up in pulling out and returning the slide is comparatively so short as to be unimportant.

The table upon which the apparatus stands should be very firm, as any disturbance during exposure shows by blurred lines.

The photographic treatment is a little different from that of usual objects. The chief aim in photo-micrography is to get definition. The negative must be sufficiently dense to give a strong print, in which the lights are high and the shadows deep, clear, and sharply outlined. To this end the exposure must be short—barely long enough to get the details and yet to keep the shadows clear—and the development excessive. This does away with the soft middle tones and gradations between the lights and shadows so essential to the beauty of landscape or portrait photography, but so disastrous to micro-photographs.

Dry plates are useful with kerosene light; the length of exposure varies greatly, and must be ascertained for each particular case. With sunlight, low powers generally require two blue cells a quarter of an inch thick, and an exposure as short as it can be made by hand. If the specimen is of rather a deep-red colour and covers the field pretty thoroughly, one cell may be sufficient, or none at all may be necessary for tempering the light.

Collodion plates with the same objectives require but one cell if the specimen is very thin and delicately coloured, and the same exposure—about one-third to three-quarters of a second. Powers from one-fifth of an inch and upward do not require any blue cell, unless there is a difference between the chemical and visual foci. For collodion plates one and a-half seconds are sufficient for the exposure with ordinary carmine-stained sections; then the time lengthens rapidly as the powers increase.

The advantages of the short exposure are, that the middle tones do not have time to be reproduced, only the marked lights and shadows are impressed, and there is much less danger of jarring the apparatus than when the exposure occupies several minutes. In a city where vehicles are constantly passing, it is impossible to get a perfectly quiet five minutes, as even what is not a very perceptible jar will mar the clearness of the outlines. Moreover, in the case of the short exposure, less time is allowed for the occurrence of unforeseen accidents.

Dry plates must be handled, as usual, under ruby light alone. Ferrous oxalate is the best developer, giving perfectly clear, white shadows; eight parts of a saturated solution of potassic oxalate, acidulated with oxalic acid, to one part of a saturated solution of ferrous sulphate, acidulated with sulphuric acid, is the usual formula. It is advantageous to add two or three drops of a saturated potassium-bromide solution. Or the development may be commenced in a normal developer, and then transferred to one containing bromide. Should the image begin to appear in a normal developer under fifteen seconds, the plate has been more than fully exposed, and very decidedly too much so for microscopical purposes. It might, perhaps, be saved by promptly adding bromide; probably, another plate must be taken. Develop until the back is quite grey in the shadows. With the ferrous oxalate developer and a properly exposed plate, there is scarcely any danger of over-development. If, after fixing, the negative appears a little too heavy in the fine details, returning it for an hour or more to a strong hyposulphite solution may restore it. If that does not bleach it sufficiently, wash and pour on and off the plate a very weak solution of potassium iodide, watching carefully all the while that the process of changing the reduced silver to an iodide does

not go too far. Then replace for a few moments in the hyposulphite solution, to dissolve out the new iodide of silver, before giving the final washing. If under-developed, no intensifications permitted by the dry-plate film will make up for it in this class of work.

Collodion plates are to be preferred, since, in addition to the possibility of making use of under-exposure and full development, certain intensifying processes may be used which take away the soft edge of the lines (caused by a slight halo around the edge of the object), and thus sharpening the outlines greatly. The dry-plate film does not permit of these processes being used; hence, in these the definition is not so good.

If the window-glass of the room in which the exposure is made is of a pretty deep orange colour, and the room long enough or so arranged that one may work where there is not too much light, the same room may be used for developing collodion plates. In the dark room an orange shade over the gas-jet gives a perfectly safe light.

Plates are prepared by thoroughly cleansing them in nitric acid, since with this former images are less likely to reappear than when caustic alkali is used for cleansing. Then flow upon the concave side the following solution of albumin:—Take the white of an egg beaten a little, and dissolve it in twenty ounces of water; add a drop of strong ammonia. The plates are then set up in a rack to dry, care being taken to shield them from dust, after which they may be set away in the dark room on some convenient shelf to keep clean until needed. If they are put in regular order, albuminised surface to the wall, it prevents confusion if one happens to be in a hurry. The albumin coat is too thin to be visible, yet it covers any little imperfection in the glass plate, and prevents it from appearing in the picture. It also makes the collodion flow more smoothly.

The usual medium negative collodion of the portrait photographer has given me quite satisfactory results. It should be filtered and then allowed to stand several hours, and decanted off the deposit before using it. Occasionally, collodion used for line work may be obtained. This works more slowly, but gives greater contrasts. Where it is desirable to make one's own collodion, the following formula has been recommended to me:—

Pure ether and strong alcohol, equal parts; for each ounce of this mixture weigh out five grains of ammonium iodide, two grains of potassium bromide, and five grains of photographic pyroxylin. Dissolve the salts in the smallest possible amount of water, and add to the alcohol. Dissolve the pyroxylin in the ether. Put the two solutions together, and filter. The collodion is now ready for immediate use. It should be made in small quantities, since it cannot be relied on to keep longer than three weeks. The sensitising bath is, as usual, forty grains of silver nitrate to the ounce of water. Ferrous sulphate developer works well, and is easily prepared:—Saturated solution of ferrous sulphate (not acidulated with sulphuric acid), four ounces; glacial acetic acid, one ounce and a half, to sixteen ounces of water. After fixing in potassium cyanide, the negatives may be set aside for a more convenient time, or intensified at once. The plate must be either entirely wet or perfectly dry before commencing, otherwise the action will be uneven. There are several methods of intensifying negatives which are useful for photo-micrographs.

I.—Lay the negative in a tray containing a watery solution of iodine and iodide of potassium, or, what is more convenient, pour on and off a strong watery solution of a deep wine colour, until the negative assumes throughout a delicate straw colour. Then wash very thoroughly to eliminate the iodine. This process may be hastened by pouring on a very dilute solution of potassium iodide. The fixing agent (cyanide) should have been carefully washed out, otherwise as fast as the deposited silver is changed into an iodide it will be dissolved as a cyanide of silver, and the image is lost. If the iodine is not washed out, it reacts with the sulphur next used, and produces a disagreeable yellowish-green colour, which interferes with the printing qualities of the negative. Finally, treat the plate with a soluble sulphide; Schlippe's salt has been used, but ammonium sulphide is the most satisfactory. Pour this on and off until the film is grey to the back; this insures that all the deposited silver is changed to a sulphide. When the negative is dried and varnished, it is ready to be printed from. This process gives a good deal of density, and is adapted to negatives from objectives of one-fifth of an inch and upward, where the exposure, being so short in order to give good definition, neces-

sarily produces rather thin negatives. With lower powers there is apt to be so much very fine detail, and a longer exposure in proportion to the amount of light, that the deposit of silver is greater, and this process gives too much density, effacing some of the details.

II.—Pour over the plate a saturated solution of the red iodide of mercury and potassium iodide, and then treat with potassium sulphide. This process is perhaps the best for very thin negatives.

III.—Where the negative does not need very much more density, treating the plate with potassium sulphide alone until the film is grey to the back will be sufficient.

The lower-power objectives I have found more useful in histological demonstrations than the higher, on account of their possessing far more penetration and a flatter field. They also allow of a greater length of bellows, equivalent to deeper eye-piecing, which makes the details larger, and thus the field. To a certain extent the size of the field is a matter of choice. I like to have it as large as possible without straining the objective, so that the details are easily seen. Objectives, being made to work at a particular distance from the object, are more or less at a disadvantage when that distance is increased or lessened. The longer the bellows, the nearer the lens must approach the object, and there are limits to this procedure which are soon reached. But the low powers bear a long bellows without being at a great disadvantage much better than the higher. This is sometimes convenient to make use of. For example: by using a one-inch-and-a-half objective and three feet twenty-six inches of camera bellows, a field, including four times as much, and of the same degree of magnification, and as clear as that from a quarter-inch objective, was gained. The specimen was not one that tried the definition much—a carmine injection of the blood-vessels in a rabbit's tongue.

High powers allow of very slight or no departure from their normal working distance, just as they do not bear deep eye-piecing. But the chief disadvantage is in the lack of penetration and in the great curvature of the field.

For the above-mentioned reasons, I think it will be found best, with tissues, to use the lowest power compatible with the resolution of the necessary details, and to keep as near as possible to the

normal working distance of the objective. A good negative may be enlarged, to bring the details of a convenient size, without losing definition.

The high-power objectives are absolutely essential for bacteria, but in this case a large field is not especially necessary, nor is the same amount of penetration required as in a section of tissue, with a variety of details to be clearly defined. The sections used in photo-micrography must be cut with a microtome, and must be thoroughly good in every respect if it is desired to obtain a good picture.

My experience with the different stains is limited. Carmine seems to work well, from a very delicate pink to a deep-red colour. Hæmatoxylin, glycerine, and nitrate of silver have all proved satisfactory. The only case that gave me any trouble was a rather thick section, deeply stained with a dark Bismarck-brown. The cell bodies were of a very brown-yellow, and obstructed the light effectually with both collodion and dry plates, so that there was no differentiation of the nuclei or other details.

Polarised light with crystals gives most brilliant photo-micrographs. The alkaloids are easily prepared, and, perhaps, present fewer difficulties for one to begin with than tissues. The polariscope is put upon the substage as usual, and the analyser screwed into the tube just above the objective. The blue cell is not necessary.

Positives or prints may be taken on albuminised paper or on the non-albuminised. The latter, if well done, gives very pretty effects in grey and white. The paper should be freshly sensitised as it is needed, and, when dried, put into a box over fumes of strong ammonia (to counteract any acidity which may be developed during the toning) for twenty minutes, and then laid away smoothly in a paper bag in a cool, dry, and perfectly dark place until required.

The printing should be carried on until the details are well marked, and a little darker than they are desired to be after the photograph is finished. The ordinary toning and fixing baths may be used. The prints on albuminised paper, when mounted, should be burnished in order to secure the best results. Prints on non-albuminised paper do not need to be burnished, but afford an

easy surface for the application of water-colours. Bromide paper of the finer qualities give excellent prints. It is also very convenient, since the same chemicals that are used for negatives are used in developing them, and the exposure can be made at any time in the dark room by gas-light.

The toning processes require a little practice in order to be successful, and need to be practically learned. Perhaps it would be more convenient for those who have but little spare time to send the negatives to one accustomed to printing line work, and who has all the appliances and chemicals at hand.

Puzzles in Palæontology.

By Mrs. Alice Bodington.

EVERY branch of biological research, whether it deals with the animal or vegetable kingdom, leads more and more to the conviction that evolution is the leading law of organic nature. Were all fossil remains of animals destroyed, embryology and comparative anatomy would lead us to the same conclusion. Indeed, so formidable are the breaks in the geological record—so formidable it is likely they will ever be—that we should be utterly at a loss to conceive what were the first beginnings of animal life, unless embryology and comparative anatomy had come to our assistance.

It was, until lately, generally believed that the rocks of the oldest, or Laurentian, series contained the remains of at least one organic being—the so-called *Eozöon Canadense*. It was considered to be a Foraminifer, belonging to the Protozoa, or lowest form of animal life. So exactly were the conditions mimicked which characterise the most complicated form of Foraminifers, that many of the wisest geologists were deceived. In fact, the question was considered as settled beyond the necessity for further discussion by Sir Charles Lyell, Dr. Carpenter, and others. Professor Moebius was destined, unwittingly, to "play the part of Balaam." In the coral reefs of Mauritius he had found a forami-

nifer, to which he gave the name of *Carpenteria raphidodendron.* He was struck by its resemblance to the description of *Eozöon Canadense*, and he was animated with the desire to establish, once and for ever, the "animalität" of Eozöon. As the greatest of living authorities upon the Protozoa, the believers in Eozöon welcomed Moebius as a Daniel come to judgment. The choicest specimens poured in upon him from every side. Carpenter sent treasures which had never before left his cabinet; Leydig of Bonn, Dawson of Montreal, gave their eager help. But, alas! he who had come to bless pronounced definitely against the animal nature of Eozöon. It sank from its proud position as the first animal—and, moreover, as an animal which could flourish in seas presumably at nearly boiling point—into "bands of serpentine, interlamellated with calcite." For a most clear and interesting account of this controversy, I would refer my readers to the papers on *Eozöon Canadense* in *Science Gossip* for April and May of the current year (1887). Heilprinn, Professor of Invertebrate Palæontology at Philadelphia, says that he has himself "examined masses of Eozöon rock, in which the network of green mineral supposed to fill the chamber cavities of the giant foraminifer *coalesce and merge into a broad band of serpentine.* Now, either here we have a true Eozöon structure or we have not. If yes, then how can the gradual convergence of the infiltrating mineral and its final coalescence in a broad band of serpentine be explained? If the contrary, what is the necessity for evoking the aid of organic forms in the explanation of a structure, *when one fully as intricate, and practically indistinguishable from it, can be shown to be of purely mineral formation?*"

The puzzle is almost equally great whether we admit or deny the animal nature of Eozöon, since above and below the band of Eozöon serpentine lie thick masses of rock without a trace of animal life. The geological break would still be stupendous. A protozöon—a mass of undifferentiated protoplasm—appears in a thin band amongst rocks some forty miles thick. There is then no further trace of life for some millions of years, when suddenly, in the Cambrian rocks, we meet with abundant remains of organic life—not in its simpler forms alone, but replete with fossils belonging to all the great zoological sub-kingdoms, with the exception of

the Vertebrata! In the words of Heilprinn, "Most of the greater divisions are already represented in the Cambrian, and, moreover, are to be found in the lowest or oldest deposit—protozoons, cœlenterates, echinoderms, worms, articulates, and molluscs. Moreover, some of these groups are already represented by a full, or nearly full, complement of the orders assigned to them by naturalists. Thus, the Cambrian echinoderms are represented by forms belonging to three out of the six usually recognised orders, viz.—the *Cystidea*, *Crinoidea* (ocean-lilies), and *Asteroidea* (star-fishes). The last two have representatives living at the present day," and form the highest development of their order. The *Crinoidea* attained their highest development in the seas of the Paleozoic period—Silurian, Devonian, and Carboniferous, and have since then been pretty steadily declining. They are now represented by not more than half-a-dozen generic species. The *Asteroidea*, on the other hand, have just as steadily been increasing, and, indeed, attain their maximum development in modern seas. Heilprinn states that "A star-fish has lately been dredged up by the *Travailleur* expedition from depths of 1,960 and 2,650 metres, having on the dorsal surface a true peduncle, apparently absolutely homologous with the stalk of a crinoid." Also, in some fixed crinoids, the "tuft" separates from the column after a certain period of existence, and then leads an independent life (*Comatula*). One might naturally suppose that the free was a later development than the fixed form, yet both *Crinoidea* and *Asteroidea* are found perfectly distinct in the oldest fossiliferous strata. The Cambrian Mollusca comprise representatives of no less than five of the six classes which now inhabit the seas, namely—the *Brachiopoda*, *Acephala*, *Pteropoda*, *Gasteropoda*, and *Cephalopoda*. Here, again, we have apparently a simultaneous appearance of lower and higher forms.

A few types of Brachiopods have survived to the present day. Thus, the *Lingula*, of the Cambrian rocks, is very little, if at all, different from the existing *Lingula*, though millions of years have elapsed since this mollusc first appeared, and higher types innumerable have run their short race and vanished.

In the Upper Cambrian, we find Molluscan forms belonging to the highest order—the *Cephalopoda*—but not to the highest type

of that order. They belonged to the four-gilled order of Cephalopods, of which one representative—*Nautilus*—alone survives. In a former paper I have alluded to the extraordinarily simple structure of the eye in this ancient mollusc. The higher two-gilled form—*Belemnites*—did not appear until the Triassic period.

The Cambrian crustaceans—the *Trilobites*—belong to an archaic type, which for ever disappeared in the Carboniferous period. Yet, unlike *Nautilus*, they possessed highly developed eyes. Two important features strike us in examining the Cambrian fauna. One is, that the forms of life, notwithstanding their number and diversity, are all salt-water animals, there being a complete absence of land and fresh-water forms. And the other main fact is the absence of any vertebrated animal. It is hardly necessary to say that the lower forms of vertebrates may have been in existence even at this early period, but of this we can never hope to have any proof. The lowest vertebrates are destitute of any hard parts which could have been preserved as fossils. We may, however, hope that in some of the still unexplored regions of the globe there may yet be found strata intermediate between the Laurentian and the Cambrian, where the first beginnings of six of the great orders of organic beings may be found.

An unaccountable break in the development of mammalian life occurs during the Cretaceous period, but it does not equal in mystery the profound break between the lifeless Laurentian rocks and the Cambrian, full of representatives of six of the great orders of the animal kingdom.

With the Silurian fauna, we find the first indisputable representatives of the great group of vertebrates, but not until the *upper* Silurian deposits are reached. We here meet with remains of two of the lower orders of fishes—the sharks or dog-fishes (*Elasmobranchii*) and the bucklered Ganoids: the former still very abundant in modern seas; the latter, which include the sturgeon and the alligator-gar, probably verging on extinction.

It is a significant fact that prior to the introduction of these low vertebrata, all the larger divisions of the Invertebrata had come into existence. The earliest *in*vertebrate air-breathers have been found in Silurian deposits, a true scorpioid (*Paleophoneus*) in the U. Silurian deposits of Sweden and Scotland, and an orthop-

teroid (*Palæoblattina*) in the nearly equivalent deposits of Calvados, France.

In the next period—that of the Old Red Sandstone, or Devonian—five or six species of insects have been found belonging to the netted veins (*Pseudoneuroptera* and *Neuroptera*), sometimes, however, considered to have belonged to an extinct race of insects. Observe, that the classes of flowering plants are still absent, and with them the flower-loving insects—the butterflies and bees. Wing fragments have been found, probably belonging to the higher order of Orthoptera (grasshoppers, cockroaches, etc.). Coincidently, there are also the first traces of land vegetation, possibly conifers, but certainly multitudes of tree-ferns, club-mosses, and gigantic forms of horse-tails (*Equisetaceæ*), fore-runners of the great forests of the Coal period. The salt-water mollusca remain much the same, but we now meet with a fresh-water mollusc—a pulmonate snail.

Simultaneously with the first appearance of vertebrates, there is a rapid decline in that ancient order of crustaceans, the *Trilobites*.

They, as well as the largest of all known articulata, the *Eurypterids*, attained their maximum development in the Silurian seas, and died out during the Carboniferous period. And this leads to the consideration of one of the most insoluble of problems in the present state of our knowledge of palæontology, namely, the laws governing the appearance, progress, and extinction of species. Whole orders of animals appear, sometimes with startling suddenness, reach apparently the highest point of which their organisation is capable, and then, for no ascertainable cause, decline and disappear. Various reasons, more or less plausible, are urged to account for the extinction of species, but all, I venture to think, are as yet empirical. Probably, the duration of life of a species is as strictly limited as the duration of life of an individual animal. It may be shortened by various accidents, but will in time come to an end, even where all external conditions are favourable.

The highest Crustaceans—the *Decapoda*—make their first appearance in the Devonian period. They belong to the less highly specialised division of the Decapods, related to the modern

shrimps. The fish have not developed beyond the low orders of Elasmobranchs and Ganoids, but their remains are so abundant that the Devonian has been called the age of fish. The bucklered Ganoids must ever be famous to all lovers of literature as well as of geology, through the eloquent descriptions of the poet-geologist, Hugh Miller. He makes us feel the thrill of passionate interest and wonder with which he beheld the strange, seemingly winged, black form which lay before him in the block of stone he had cleft. And there, in hundreds and thousands, did he afterwards find these strange shapes, their wing-like fins stiffened and distorted, as though they had died in an agony of pain—as if the waters of some boiling sea had surged over them, or so they seemed to the self-taught genius who first beheld them.

Some of the Devonian fishes are remotely related to the sturgeon of modern seas, also to the fringe-finned *Polypteri* of Africa, and the alligator-gars of America. But many groups are totally extinct. In the Silurian seas the fish attained their largest size. The giant *Dinichthys* and *Titanichthys* were between twenty and thirty feet long. Their dentition is like that of the *Lepidosiren* (belonging to the lung-fishes, or Dipnoi), a group of fishes transitional between the true fishes and the amphibians.

In the Carboniferous epoch the transition has been completed, and we find animals which have developed true lungs, though all breathe with gills during some portion of their existence. These early amphibians all belonged to the extinct order of Labyrinthodonts, frog-like in some anatomical characteristics, but in form most nearly resembling newts or salamanders.

"A monstrous eft was of old the lord and master of earth:
For him did the high sun flame, and his river billowing ran;
And he felt himself, in his force, to be Nature's crowning race."

And we know now that these same monstrous efts had probably a large eye in the centre of their skulls, projecting through the parietal suture and moved by powerful muscles. From our childhood we have, with our mind's eye, beheld these monstrous amphibians and saurians of primæval ages, and now they loom before our imagination in still more monstrous semblance with *three* huge eyes!

There are no traces of the higher plants in the forests of the

Coal period, and, though the remains of insects are abundant, there were as yet none of the nectar-sucking, pollen-loving species. Neither *Lepidoptera* nor *Hymenoptera* are found.

In the next age—the Permian—the remains of reptiles are, for the first time, found. But we can hardly suppose that they now made their first appearance in the world. They are highly specialised in many ways; their teeth are distinctly differentiated into incisors and canines, and they show strong affinities to the lowest mammals in the structure of their pectoral and pelvic girdles. In one important particular they show an embryonic condition like that of the Ganoids—their vertebral column is only partially ossified.

The Mesozoic period—from the Permian to the end of the Cretaceous—is the great age of reptiles. They attain dimensions unequalled by any other animal. Even the whale could not compete in size with *Atlantosaurus*, which measured forty feet in height and from eighty to a hundred feet in length, and whose thigh-bone exceeds in length the whole body of a powerful man. It belonged to the wonderful order of Deinosaurs, for whose fate I always feel a sympathy. In their organisation they approached as nearly as any reptile has ever done to warm-blooded creatures. Some were of stupendous size; others rivalled true birds in their flight; others were furnished with rows of terrible, trenchant teeth, showing their carnivorous nature. Yet all these deinosaurs perished in the age that brought them forth. They would have left no testimony of their existence but their bones, had we not reason to suppose that some of the deinosaurs did become warm-blooded, and died out as deinosaurs, to spring into existence as birds. The small deinosaur found with the first bird in the lithographic slate of Solenhaufen is, like the first bird, of so mixed a character in its whole anatomy, that it is hard to say where the reptile ends and where the bird begins. Perhaps we may venture to conjecture that the first bird of Solenhaufen, with its toothed beak and long reptilian tail furnished with feathers, and with its reptilian hand ending a bird-like wing, represented a form in which the arterial had for the first time been completely cut off from the venous blood; and that the bird-like reptile, *Compsognathos*, had still impure blood in its veins.

Other marvellous reptiles lived and died in the Mesozoic period. The *Theriodontia* were powerful and ferocious beasts of prey, with teeth of the carnivorous type. The *Anomodontia* had beaks encased in horn, after the fashion of modern turtles. The Ichthyosaurus and Plesiosaurus are types of two orders, comprising great fish-like reptiles, or "sea-lizards." Both have but a short geological existence; they appear in the lias and disappear in the succeeding chalk. There were also the Pterosaurs, which were, in relation to other reptiles, what the bat is compared to other mammals.

Modern reptiles, like the insectivorous mammals of Europe, are poor and humble survivals of a numerous and powerful race. In England the great "dragons of the prime" are represented but by such small and harmless amphibia as the frogs and newts; and the crocodiles of the Nile, and the alligators of Florida, are themselves hardly more than newts compared to that greatest of earthly giants, *Atlantosaurus*. Amongst the most inexplicable problems of palæontology are the laws, at present undiscovered, which led to the extinction of these huge reptiles. In the Upper Trias appeared some small and feeble mammals, of about the size of mice. Who could have guessed that these small, frail creatures were the ancestors of the future lords and masters of the world; that the gigantic and highly-organised Deinosaurs, the terrible "Sea-Lizards," and the fierce *Theriodontia*, would all die out, and that the descendants of these small creatures—these milk-givers with warm blood—would survive them? What but a law governing the duration of species could have destroyed these huge reptiles? Rivals, capable of harming them, did not exist. What happened between the laying down of the Cretaceous rocks and the succeeding Eozoic period, during which the small mammals (of marsupial and insectivorous affinities), which first appeared in the Upper Triassic and Jurassic rocks, expanded into countless herds, representing every natural order of mammals of the present day? And the giant reptiles are all things of the past!

In the beds of Upper Jurassic age, on the western slope of the Rocky Mountains, Professor Marsh has found the remains of several hundred mammals. Here, at the dawn of mammalian life, we already meet with three distinct orders, all so far special-

ised that their origin must be sought for in paleozoic times. Unnumbered ages ago—before the Cretaceous and Oolitic strata were laid down—there were already placental and implacental mammals. The former, which Prof. Marsh proposes to call *Pantotheria*, possessed, amongst others, the following characteristics:—their teeth equalled or exceeded the normal number, some types possessing sixty teeth. Their pre-molars and molars were imperfectly differentiated, without or with hardly any diastemas, and possessed numerous cusps of the insectivorous type; the canines sometimes well marked and trenchant, sometimes differing little from the molars. The jaws were usually very long, as became animals which could boast of sixty teeth. But even then specialisation had had time to work effectually; the genus *Paurodontidæ* had short and massive jaws, with but six pre-molars and molars on each side; yet the *character* of the dentition is the same as in the many-toothed forms. The *Pantotheria* were probably all insectivorous, with such vegetable additions as the insectivora will still feed upon.

The second order to which all the other American Jurassic mammals but one are referred by Professor Marsh, is called by him "*Allotheria*." Their characteristics are strikingly different to those of the *Pantotheria*: their teeth are much *below* the normal number, and the compressed pre-molars are marsupial in type; the canine teeth are wanting; the pre-molars and molars are specialised. They were probably a sub-order of marsupials, somewhat resembling the kangaroo rats. Some were of minute size; the largest was about the size of a rat.

Of the third group of Jurassic mammals, but one lower jaw has been found, but this is so characteristic, and so different from other forms, that it has been placed in a distinct group by Professor Marsh, under the name of *Diplocynodontidæ*.

Surely, the puzzle of evolution, from the palæontological point of view, has been made more instead of less intricate by these last discoveries. We now know that the two great lines of placental and implacental mammals have come down side by side for some millions of years, and when we first find their remains the species are so highly specialised, and so much differentiated, that we know their first beginnings must be put indefinitely further back.

Imperfect as the geological record is, the direction of progress is always from the lower types to the higher, though the steps may be often obliterated. And, in some mysterious manner, the evolution of the higher types seems coincident with the fading away of types immediately lower. It is in the *Atlantosaurus* beds, so called from that hugest of deinosaurs, that these earliest American mammals are found. The largest of these mammals was no larger than a weasel, yet the great reptiles gradually faded out of the world before these small, warm-blooded creatures.

On the threshold of the Tertiary period I will bring this paper to a close. The puzzles of Palæontology are equally insoluble in Kainozoic times, and more nearly affect ourselves. Their mere statement would require another paper, and I have already trespassed too far on the space of this journal.

Authorities consulted :—

Professor Marsh, "American Jurassic Mammals," *Geological Magazine*, June and July.

Heilprinn's "Geological and Geographical Distribution of Animals."

Nicholson's "Palæontology."

"Eozöon Canadense," *Science Gossip*, April and May, 1887.

The Structure of Flowers with reference to Insect Aid in their Fertilisation.

By W. G. Wheatcroft.

Plate 24.

IN the year 1793 Christian Conrad Sprengel published his interesting treatise on the structure of flowers with special reference to insect aid in their fertilisation. This book was almost wholly neglected for more than half a century. Nevertheless, it contains, with some fanciful ideas, the germs of the doctrine now generally held, together with many excellent illustrations of it.

That eminent naturalist, the late Charles Darwin, published in 1862 his admirable treatise on the fertilisation of orchids by the aid of insects. Since that time a copious special literature has appeared on the subject. We may mention the names of Herman, Müller, Delpino, Hugo von Mohl, and Hildebrand, amongst Continental writers; Charles Darwin and Sir John Lubbock, amongst our own countrymen; and Dr. Asa Gray and Dr. Goodale amongst our brethren across the Atlantic.

Linnæus and his immediate successors taught that the adjustments in hermaphrodite flowers were such on the whole as to secure the application of the pollen of its stamens to the stigma of its pistil or pistils. "The present view," to quote the words of Dr. Asa Gray, "is that this is doubtless strictly secured in certain flowers of a moderate number of species, but never in all the flowers of any such species; that in ordinary flowers where it may commonly take place, it is not universal; that in the larger number of species there is something or other in the floral structure which impedes or prevents it." It will be gathered from this definition that some flowers are adapted for close fertilisation, some for cross-fertilisation, some for either. Before proceeding further, let me state for the information of those who have not given much attention to the construction of flowers that they consist of two kinds of organs, viz., what have been apparently called protecting organs or floral envelopes, which when of two sets are named calyx and corolla; and the essential reproductive organs which co-operate in the production of seed—the stamens and pistils.

"A complete flower," to quote from Sir John Lubbock, "consists of (1) an outer envelope or calyx, sometimes tubular, sometimes consisting of separate leaves called sepals; (2) an inner envelope or corolla which is generally more or less coloured, and which like the calyx is sometimes tubular, sometimes composed of separate leaves called petals; (3) of one or more stamens, consisting of a stalk or filament and a head or anther, in which the pollen is produced; and (4) a pistil or an ovary, which is situated in the centre of the flower and contains one or more seeds or ovules. The pistil consists of a stalk or style and a stigma, to which the pollen must find its way in order to fertilise the flower, and which in many familiar instances forms a small head at the top

of the style. In some cases the style is absent and the stigma is consequently sessile." For our present purpose the stamen may be regarded as the fertilising organ, and the pistil as the seed-bearing organ. In an ordinary flower the pistil is surrounded by a row of stamens, and at first sight it would appear that a more simple arrangement for the reproduction of the plant could not well be contrived. The pollen would seem to be arranged to fall upon and dust the stigma of the pistil, and effect what is known as close fertilisation. This does happen with some flowers, chiefly with the inconspicuous ones. In the largest number of flowers with a gay corolla, or which emit a sweet scent and possess honey-glands, cross-fertilisation is the rule and close fertilisation the exception.

There are various contrivances in these flowers which effectually prevent self-fertilisation. In many species the stamens and pistils are situated in different flowers. Such species are named diclinous; when the stamens and pistils are situated in different flowers on the same plant, the species is called monœcious; when on different plants diœcious. Delpino has classified flowers into Anemophilous (literally wind-lovers) and Entomophilous (insect-lovers), denoting wind-fertilised and insect-fertilised. It is not my purpose in this paper to treat of the former, but will observe that wind-fertilised flowers are mostly neutral or dull in colour, destitute of odour and honeyless. Pines, firs, and other *Coniferæ* are examples of anemophilous plants. Dr. Asa Gray observes that "Insect fertilisable or entomophilous flowers are correlated with showy colouration (including white, which is most showy at dusk), odour or secretion of nectar, often by all three modes of attraction to insects combined. Some insects, moreover, visit flowers for their pollen, a highly nutritious article, and ordinarily produced in such abundance that much may be spared. The showiness of the corolla or other floral envelopes is an attractive adaptation to fertilisation, enabling blossoms to be discerned at a distance; nor do we know that fragrance or other scent, or that nectar, subserves any other uses to the flower than that of alluring insects."

Adaptations in the pollen of such blossoms for transportation by insects are various. Commonly the grains are slightly moist or glutinous, or roughish, or studded with projection, or strung with

threads (as in *Œnothera*), so as not to be readily dispersed in the air, but to have some slight coherence as well as capability of adhering to the head, limbs, or bodies of insects, especially to their rough surfaces; and in two families (*Orchidaceæ* and *Asclepiadaceæ*) the pollen is combined in masses and with special adaptations for being transported *en masse*. With this the stigma is usually correlated, by roughness, moisture, or glutinosity." Sprengel was the first to discover that in many species where the stamens and pistils are situated in the same flower they do not mature at the same time; consequently the pollen cannot fertilise the stigma. Sometimes, as in the Arum, the pistil matures before the anthers. Such plants are called proterogynous (or protogynous). In others the anthers mature before the pistil. These plants are named proterandrous (or protandrous). The familiar *Arum maculatum*—(Plate XXIV., Fig. 2)—the common arum or lords and ladies—of our woods and hedges is a good example of a proterogynous plant. The well-known green leaf encloses a central pillar which supports a number of stigmas near the base, and of anthers somewhat higher. Nothing would seem easier at first sight than that the pollen of the anthers should fall on and fertilise the pistils below them. But this does not take place. The stigmas mature before the anthers, and by the time the pollen has fallen have become incapable of fertilisation. It is consequently impossible for the plant to fertilise itself. Owing to the construction of the spathe the pollen cannot be carried away by the wind. What happens is as follows: The pollen when shed drops to the bottom of the tube, where it remains secure from disturbance by wind. Small insects attracted by the showy central spadix, or the prospect of honey or shelter, enter the tube while the stigmas are mature. Above the anthers and growing from the central pillar is a fringe of hairs pointing downwards. This contrivance allows small insects to enter, but effectually prevents their exit until the stigmas have matured. After a while, the stigmas have ripened and each secretes a drop of honey, thereby rewarding the insects for their imprisonment. Then the anthers ripen and shed their pollen, which falls upon and dusts the insects. Shortly after the hairs referred to shrivel up and the insects are set free. They carry the pollen with them, and on their visit to another plant can hardly fail to deposit some of it on the stigmas.

In this manner cross-fertilisation is secured. I have often noticed a large number of small insects, especially flies, safely imprisoned in the Arum before the hairs have shrivelled up.

Proterandrous plants, or those in which the anthers mature before the stigmas, are much more numerous. As examples amongst the wild flowers which are to be found in this locality,* I must mention Wild Thyme (*Thymus serpyllum*), Rose Bay, Willow Herb, *Epilobium augustifolium*, Blue Meadow Crane's Bill (*Geranium pratense*), Mountain Crane's Bill, (*G. pyrenaicum*), with many of the *Umbelliferæ* and most of the *Compositæ*. Sir John Lubbock states that most of the British wild flowers which contain both stamens and pistils are more or less proterandrous. These are almost dependent upon the visits of insects for fertilisation. Amongst foreign plants now common in conservatories, *Clerodendron Thompsonii* (Pl. XXIV., Fig. 1), a verbenaceous African climber, is a good example of a proterandrous plant. Its crimson corolla and bright white calyx in combination are very conspicuous and serve to attract insects. The long filiform filaments and style, upwardly enrolled in the bud, straighten and project when the corolla opens, the stamens remain straight, but the style proceeds to curve downward and backward, as shown at *a*; the anthers are represented discharging the pollen; the stigmas are immature and closed; *b* represents the flower on the second day, and anthers effete, and the filaments recurved and rolled up spirally; while the style has taken the place of the filaments, and the two stigmas, now separated and receptive, are in the very position occupied by the anthers the previous day. The entrance by which the proboscis of a butterfly may reach the nectar at the bottom is at the upper side of the orifice. It is impossible for the flower to self-fertilise. A good sized insect flying from flower to flower, and plant to plant, must carry pollen from one to the stigma of the other.

I cannot help calling attention to the mode in which cross-fertilisation is secured in the Blue Meadow Crane's Bill (*Geranium pratense*), Fig. 3, for several reasons. This beautiful Crane's Bill, with its lovely blue corolla and elegant leaves, must be well-known to all who stroll in the meadows adjoining the Avon

* Bath.

or by the brooks in the neighbourhood of this fair city. It is especially interesting as the flower which first led Sprengel to his researches. "In the year 1787," writes Sir John Lubbock, "he (Sprengel) observed that in the corolla of this species there are a number of delicate hairs, and convinced, as he says, 'that the wise Author of Nature would not have created a single hair in vain,' he endeavoured to ascertain the use of these hairs and satisfied himself that they served to protect the honey from rain." Another point of interest in this flower is the spontaneous movement of the stamens and pistils. Kolreuter seems to have been the first to observe this motion in another dichogamous plant, *Ruta graveolens*. He supposed that the object was to bring the stamen in contact with the pistil and so insure close fertilisation. Nature, as Sprengel pointed out, had a very different purpose to fulfil. It was to bring the stamen and pistil successively in contact with the same part of the insect's body, and so insure cross-fertilisation. When the flower first opens, the stamens lie on the petals, at right angles with the upright pistils. As they come to maturity they raise themselves parallel, and close to the pistil, which is, however, not yet capable of fertilisation. After they have shed their pollen they return to their original position and the stigmas unfurl themselves. As the stigmas do not become mature until all the stamens have shed their pollen, *G. pratense* is wholly dependent upon insect aid for fertilisation. The spontaneous movement thus ensures cross-fertilisation, and indicates another of Nature's plans for bringing about the end desired by making certain insects the carriers of the pollen.

I will now direct attention to another very successful arrangement for promoting cross-fertilisation through the agency of insects. Probably many have noticed the Primroses (*Primula vulgaris*, Fig. 4) present different appearances with regard to the stamens and pistils. In some the pistil is found at the top of the tube, and the stamens half way down; in others the stamens are at the top of the tube, and the pistil half way down. Corresponding differences may be seen in the Cowslip (*P. veris*), Polyanthus, and Auricula. This difference in the form of the flowers has long been known by the homely names of "thrum-eyed and pin-eyed." Plants which present these differences of form are known

as heteromorphous; those which have two forms of flower, like the primrose, as dimorphous; and those which have three forms, as in *Lythrum salicaria* (Purple Loosestrife), as trimorphous. Sprengel, as Darwin mentions, had noticed this difference in form in *Hottonia* before 1793. "Sprengel," writes Darwin, "with his usual sagacity, adds that he does not believe the existence of the two forms to be accidental, though we cannot explain their purpose." Trimorphism was noticed by Vaucher in 1841, and by Wirtgen in 1848. It was left to our great naturalist, Charles Darwin, to interpret, in the Journal of the Linnæan Society, 1862, this curious phenomenon.

Referring to dimorphism in the case of the primrose, Sir John Lubbock observes, "An insect thrusting its proboscis down a primrose of the long-styled form, would dust its proboscis at a part which, when it visited a short-styled flower, would come just opposite the head of the pistil, and could not fail to deposit some of the pollen on the stigma. Conversely, an insect visiting a short-styled plant would dust its proboscis at a part further from the top; which when the insect consequently visited a long-styled flower would again just come opposite the head of the pistil. Hence we see that by this beautiful arrangement insects must carry the pollen of the long-styled form to the short-styled, and *vice versa*." Mr. Darwin has shown that much more seed is set, if pollen from the one form be placed on the pistil of the other, than if the flower be fertilised by pollen of the same form, even taken from a different plant.

This eminent naturalist, in his interesting work on the forms of flowers, after giving a minute and graphic description of trimorphism in the case of *Lythrum salicaria* (Purple Loosestrife), observes, "In a state of nature the flowers are incessantly visited for their nectar by hive or other bees, various Diptera, and Lepidoptera. The nectar is secreted all round the base of the ovarium; but a passage is formed along the upper and inner side of the flower by the lateral deflection of the basal portion of the filaments; so that insects invariably alight on the projecting stamens and pistils, and insert the proboscis along the upper and inner margin of the corolla. We can now see why the ends of the stamens with their anthers, and the end of the pistil with the

stigma, are a little upturned; so that they may be brushed by the lower hairy surfaces of the insects' bodies. The shortest stamens, which lie enclosed within the calyx of the long and mid-styled forms, can be touched only by the proboscis and narrow chin of a bee; hence they have their ends more upturned, and they are graduated in length, so as to fall into a narrow file, sure to be raked by the thin, intruding proboscis. The anthers of the longer stamens stand laterally further apart, and are more nearly on the same level, for they have to brush against the whole length of the insect's body.

"I have found no exception to the rule that when the stamens and pistil are bent, they bend on that side of the flower which secretes nectar. . . When nectar is secreted on all sides, they bend to that side where the structure of the flower allows the easiest access to it, as in *Lythrum*. . . In each of the three forms, two sets of stamens correspond in length with the pistil in the other two forms. When bees suck the flowers, the anthers of the longest stamens, bearing the green pollen, are rubbed against the abdomen and inner sides of the hind legs, as is likewise the stigma of the long-styled form. The anthers of the mid-length stamens, and the stigma of the mid-styled form, are rubbed against the under side of the thorax and between the front pair of legs. And lastly, the anthers of the shortest stamens, and the stigma of the short-styled form, are rubbed against the proboscis and chin; for the bees in sucking the flowers insert only the front part of their heads into the flower. On catching bees, I observed much green pollen on the inner side of the hind legs, and on the abdomen, and much yellow pollen on the under side of the thorax. There was also pollen on the chin, and, it may be presumed, on the proboscis; but this was difficult to observe. I had, however, independent proof that pollen is carried on the proboscis; for a small branch of a protected short-styled plant (which produced spontaneously only two capsules) was accidentally left during several days pressing against the net, and bees were seen inserting their proboscides through the meshes, and, in consequence, numerous capsules were formed on this one small branch. . . It must not, however, be supposed that the bees do not get more or less dusted all over with the several kinds of

pollen; for this could be seen to occur with the green pollen from the longest stamens. . . Hence insects, and chiefly bees, act both as general carriers of pollen, and as special carriers of the right sort."

A long series of experiments proved that both kinds of pollen are nearly or quite impotent upon the stigma of the same flower, and that no ovary is fully fertilisable in any other manner than by stamens of the corresponding length. *Nesæa verticillata*, a common Lythraceous plant of the Atlantic United States, is, according to Dr. Asa Gray, similarly trimorphous. Several South African and American species of Oxalis are trimorphous, and have been investigated by Darwin and Hildebrand, with the same result as in *Lythrum salicaria*. Referring to trimorphism, Mr. Darwin observes in one of his valuable works, as follows:— "Fritz Müller has seen in Brazil a large field, many acres in extent, covered with the red blossoms of one form (of an Oxalis) alone, and these did not produce a single seed. His own land is covered with the short-styled form of another species, and this is equally sterile; but when the three forms were planted near together in his garden they seeded freely." "All known flowers," writes Dr. Asa Gray, "exhibiting reciprocal dimorphism, or trimorphism, are entomophilous" (insect fertilisable). No such wind-fertilisable species is known. Few of them are irregular, and none very irregular; they do not occur, for instance, in *Leguminosæ*, *Labiatæ*, *Scrophulariaceæ*, *Orchidaceæ*, etc. Nature is not prodigal, and does not endow with needless adaptations flowers which are otherwise provided for.

The last, but not the least remarkable example of the adaptation of flowers to the visits of insects for the purpose of fertilisation to which I will allude is that of the Orchidaceous family of plants. The flower of the Orchis is very abnormal. Its genera vary amazingly in the structure of the anther, the column, the lip, and indeed of all parts, but in the consolidation of the style and stamen they are all agreed. "The flowers," to quote the words of an eminent modern botanist, Otto W. Thomé, "are rarely solitary, usually in spikes, racemes, or panicles; and the superior perianth consists of two whorls, each of three leaves. Of these, the inner whorl is always irregular, and often has a spurred lip or

labellum, the remaining five leaves of the perianth forming together the galea or helmet. The stamens are united with the style into a fleshy column or gynostemium, upon which the anthers are so placed as to stand above the stigma, which is but little developed, and consists usually of a large viscid surface. Of the six stamens which are probably originally present, only one, less often two, attain perfect development. When only one is thus developed, it is always opposite the labellum; but when two, then one is on each side of the gynostemium. Only a few Orchids have the pollen grains perfectly distinct; usually they are united together in fours, and these again into granular masses; or the grains are combined by a viscid fluid into a club-shaped mass or pollinium within each anther lobe. The two pollinia terminate at their lower end in a pedicel consisting of the dried-up viscid substance, connected together by a viscid gland or rostellum, as in the Bee Orchis, or distinct, as in *Orchis morio*."

If we dissect a flower of the early purple orchis, we shall find that the stigma is bilobed, and consists of two almost confluent stigmas. It lies under the pouch-formed rostellum. The anther consists of two rather widely separated cells, which are longitudinally open in front: each cell includes a pollen mass or pollinium. The pollinium consists of a number of wedge-shaped packets of pollen grains united together by exceedingly elastic thin threads. Below the pollen mass is the elastic caudicle. The end of the caudicle is firmly attached to a viscid button-shaped disc. Each pollinium has its separate disc, which has a ball of viscid matter at its under side. The rostellum lies immediately below, and the balls of viscid matter lie concealed within it. Let me now try to explain how this mechanism acts. Suppose an insect, say a bee in search of honey, to alight on the labellum, which forms a good landing stage, and to push its head into the chamber, at the back of which lies the stigma, in order to reach with its proboscis the end of the nectary, or what does quite as well to show the action, push a sharply pointed lead pencil into the nectary. Owing to the projection of the pouch-formed rostellum, it is almost impossible to push an object into the gangway of the nectary without touching the rostellum. When this is effected one or both of the viscid balls will almost invariably touch the intruding body.

These balls are so viscid that they stick firmly to whatever they touch, and the viscid matter sets hard and dry like cement within a minute or so. As the anther cells are now open in front, when the insect withdraws its head, or when the pencil is withdrawn, one or both pollinia will be withdrawn firmly attached to the object, sticking up like horns. The firmness of the cement is necessary, for if the pollinia were to fall sideways or backwards they would never fertilise the flower. Now let us suppose the insect to fly to another flower, or insert the pencil with the pollinium attached into another nectary. If this be done at once it is evident that the pollinium will be pushed into or against its old place, the anther cell. How then can the flower be fertilised? This is effected by a very beautiful contrivance. Within a minute the pollinia, by the contraction of the minute disc to which they are attached, move downwards to an angle of about 45 degrees from the first upright position. When the insect sucks the next flower the pollen masses come in direct contact with the stigmatic surface. The stigma is so very viscid that it is certain to pull off some of these pollen packets and rupture the threads. The whole pollinium is scarcely ever retained by the stigma, so that one pollinium serves to fertilise several flowers. So economical is Nature in her workings that even a few pollen masses are not unworthy of her sedulous care.

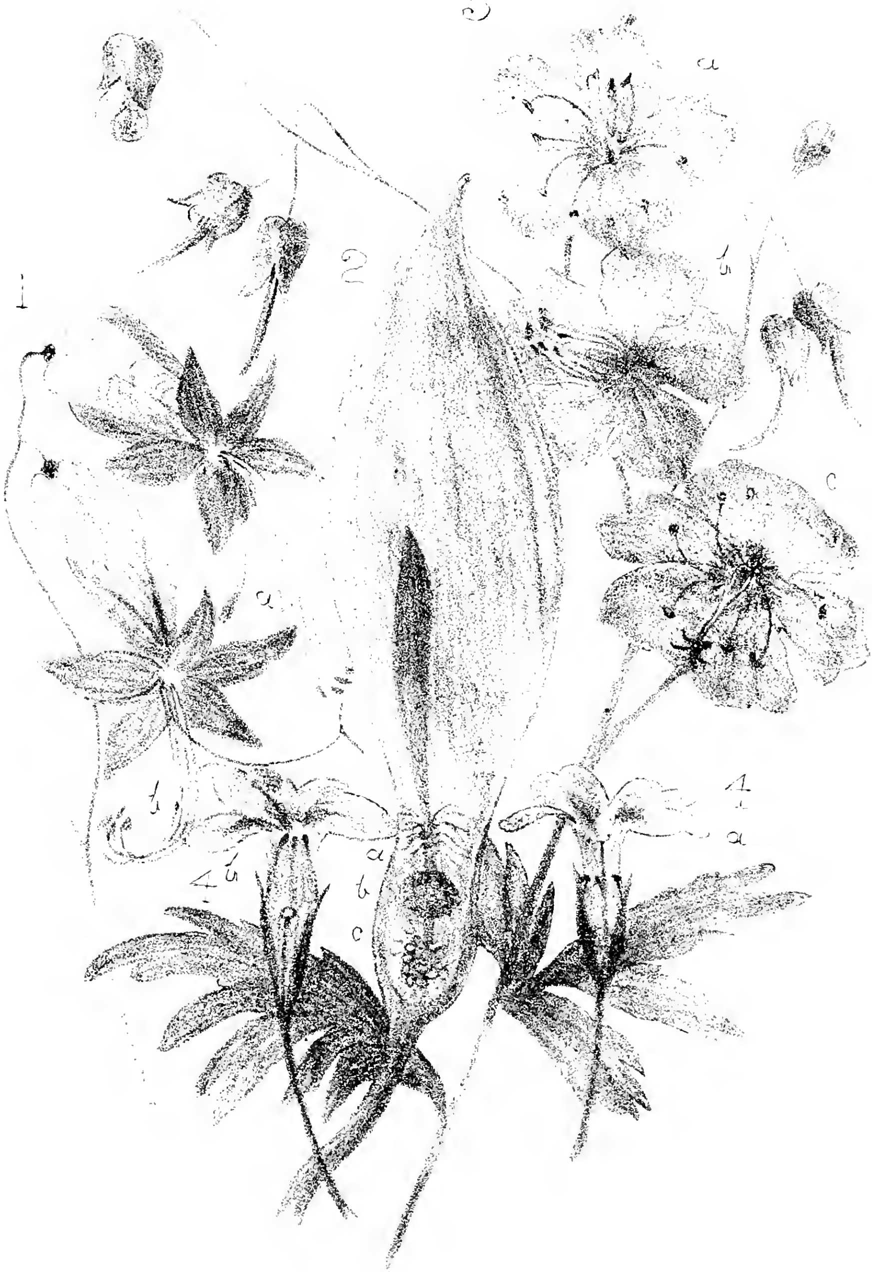
Of all the pollen-carriers, and consequently flower-fertilisers, bees are the most assiduous. Attracted by the gay colours of the corolla, sweet scent, or the prospect of honey, they visit most flowers that are incapable of self-fertilisation. That bees can distinguish between one colour and another, and that they exhibit a preference for certain colours, has been clearly proved by Sir John Lubbock and others. The bodies of some bees, and the legs of others, are so admirably adapted for the collection and carriage of pollen, that it is almost impossible for them to visit any flower in pursuit of honey without bearing away a large quantity of pollen grains. The body of the humble bee (*Bombus terrestris*) is the best adapted for pollen carrying. Lepidoptera stand next in order of importance to bees as pollen carriers. Their long proboscides enable them to drain nectaries which less favoured insects cannot reach. The despised wasp is not without

its use as a fertilising agent; for, according to Mr. Darwin, "if wasps were to become extinct in any district, so would *Epipactis latifolia*."

Honey, I need scarcely say, is the principal object of attraction to bees, butterflies, moths, and many other insects which assist in the work of fertilisation. It is secreted by specialised organs known as nectar glands. "In the flower," according to Dr. Goodale, an eminent American botanist, "these glands consist usually of specialised parenchyma, not unlike the secreting surface of the stigma." "Nectar glands," continues the author, "may occur in any part of the flower, upon its bracts, or upon some part of the flower-stalk near it. From the nectar glands of proper floral organs the secretion of nectar is generally copious, and is prone to collect in minute cavities, such as shallow pits, or in conspicuous special receptacles, the so-called nectaries. The period of most copious secretion of nectar usually coincides with the maturity of the anthers or of the stigma." Here we perceive another of Nature's beautiful contrivances for carrying out her purposes. Just at the time when the pollen is ready to do its work of fertilisation, or the stigma to receive it, a copious supply of honey both attracts and rewards the insect pollen-carriers.

The odours of flowers must be classed amongst the most potent attractions of insects. White flowers are more generally fragrant than those of any other colour. As examples of the accuracy of this proposition, I would refer to those delicately-scented flowers, the Lily of the Valley, the Jasmine, and the Butterfly orchis. I cannot do better than quote the words of Mr. Darwin in explanation of this:—"The fact of a large proportion of white flowers smelling sweetly may depend in part on those which are fertilised by moths requiring the double aid of conspicuousness in the dark, and of odour. So great is the economy of Nature that most flowers which are fertilised by crepuscular or nocturnal insects emit their odour chiefly or exclusively in the evening."

I have ventured to call attention to a comparatively large number of important facts, and for the purpose of giving my authorities have quoted largely. If these quotations have the effect, as I trust they may, of directing attention to, and inducing



Flowers with reference to Insects

a perusal of, the works referred to, this paper will not have been written in vain. It will naturally be asked, Why has Nature planned all these contrivances to bring about cross fertilisation? Mr. Darwin has clearly proved that plants which are the product of cross-fertilisation are both stronger in constitution, and more prolific in seed-bearing, than those resulting from close-fertilisation. Another and more important result may have been designed, namely, the origin of new varieties and new species. If we consider how much the skilled nursery-man has effected, within living memory, in the direction of producing new varieties in such well-known plants as roses, strawberries, pelargoniums, primulas, and a host of other flowering and fruit-bearing plants, we may readily understand how pollen-carrying insects may, in the countless ages that have passed, have been instrumental in effecting changes of a similar character in plant development. That pollen-bearing insects, such as bees and moths, have been largely engaged in helping to clothe this earth of ours with some of its most beautiful forms, cannot, I think, in the present state of knowledge, be doubted. Devout minds, like that of Christian Conrad Sprengel, will perceive the wisdom and goodness of the great Creator, operating by means of natural agencies, in producing beautiful forms of plant life to delight the senses and supply the wants of His creature man. Even the atheist, on thoughtful consideration, must admit that the vegetable world, and especially the flower-bearing portion of it, affords ample evidence of design.

EXPLANATION OF PLATE XXIV.

Fig. 1.—*Clerodendron Thompsonia.* *a*, Flower on first day, anthers discharging pollen, pistils immature. *b*, Flower on second day, anthers effete, pistils mature and receptive.

,, 2.—*Arum maculatum.* *a*, Hairs; *b*, Anthers; *c*, Stigmas.

,, 3.—*Geranium pratense.* *a*, Flower when first open. *b*, Flower, with anthers at maturity. *c*, Flower after anthers have become effete and pistil mature.

,, 4.—*Primula vulgaris.* *a*, Long-styled or Pin-eyed. *b*, Short-styled or Thrum-eyed.

The Microscope and How to Use it.

By V. A. Latham, F.M.S.

Part XII.—Section-Cutting.

IT is of the utmost importance that the student should thoroughly master the details of cutting sections by hand and also with the aid of the microtome. For convenience we will divide section-cutting into two classes, viz.—(1) Methods of cutting by hand; (2) with the microtome.

Unhardened Tissues.—If it be desirable to examine only a small piece, snip off a thin fragment with a pair of scissors curved on the flat, or cut off a slice with a Valentine's knife.

Hardened Tissues.—If the piece of tissue be large enough, hold it between the index-finger and thumb of the left hand, take the razor firmly in the right, with the fingers closed above the handle, support the back of the razor on the index-finger of the former, and keep the handle in a line with the blade, cut from *left to right* and from *heel to tip* through the tissue *towards yourself.* Be sure the razor is very sharp and keep the blade well wetted with spirit, into which also the cut specimens must be floated off with a camel's hair brush after each sweep of the razor, unless the specimen has been already stained and dehydrated, in which case clove-oil is to be used instead of the spirit for wetting the razor.

The army razor is all that is required for ordinary use, and should always be stropped in one direction. If the tissue is *too* small or delicate to hold in the hand, it must either be clamped or embedded in some substance.

(*a*) Place the tissue to be cut between two pieces of amyloid or waxy liver, or in the liver of a pig hardened in alcohol, hold tightly between the finger and thumb, and cut with a razor in the above manner.

(*b*) Carrot, turnip, potato, or elder pith may be used instead of liver. Make a slit in the carrot, and clamp the tissue in it. The usual way, however, is to embed the specimen in a wax mass or some other mixture.

EMBEDDING MIXTURES.

(*a*) White wax or olive oil, equal parts: melted and well mixed. This mass may be varied in consistency by diminishing the olive oil used.

(*b*) **Spermaceti and Castor Oil.**—Four parts of spermaceti and one part of castor oil.

(*c*) **Cocoa Butter** may be used alone, or combined with paraffin wax, or spermaceti and paraffin.

(*d*) **Paraffin and Lard.**—Take 5 parts (by weight) of solid paraffin and one of hog's lard and of paraffin oil: melt at a gentle heat, and mix thoroughly.

(*e*) **Paraffin and Vaseline.**—Two parts solid paraffin mixed with one of vaseline makes a transparent mass.

(*f*) **Glycerine and Tragacanth.**—Take two drms. of glycerine and mix with 1½ drms. of powdered gum tragacanth. The tissue is cut and placed in a pill-box, and the mixture poured in. If the specimen is to be preserved for a longer time, the bottom of the box may be taken off and the side slit up. The specimen will be embedded in a solid elastic cake, and may be slipped into alcohol until required. When it is to be kept in spirits less than 24 hours, the mixture should be glycerine, 2 drms.; tragacanth (powdered), 9 drs.; gum arabic, 15 grs. Tissues that have lain in spirit should be steeped in cold water for a few hours before embedding.

The embedding mixtures may be arranged as follows:—

Solid paraffin, 3 parts; Cocoa Butter, 1 part; Hog's Lard, 3 parts. Soft.

Solid Paraffin, 3 parts; Cocoa Butter, 2 parts; Spermaceti, 1 part. Hard.

Solid Paraffin, 3 parts; Cocoa Butter, 1 part; Spermaceti, 1 part. Harder.

Paraffin, 2 parts; Vaseline, 1 part. Transparent and easy to cut.

These are very common mixtures for embedding, although Mr. Cole recommends them only to "those who are fond of messes, and the method is mentioned only to condemn it as unnecessary and dirty in every way." Notwithstanding this terrible denunciation, this method will continue to occupy its position

as an easy way of holding a tissue firmly in place, and without injury to it or to the knife.

Tolu instead of Chloroform for Embedding in Paraffin.—Objects embedded in paraffin can be better and more easily cut when they have been previously treated with tolu instead of chloroform. After the object has been hardened in alcohol, it is placed directly into tolu for 24 hours (or less for small objects), and transferred from it to the paraffin-bath, in which it is also kept for 24 hours (Dr. M. Holt).*

Embedding Small Objects (Dr. L. Gerlach).—This is very useful for embryos or parts of embryos. Take 40 grammes gelatine, added to 200 ccm. of a saturated solution of arsenious acid with 120 cc. of glycerine. This fluid must be clarified with white of egg and will remain perfectly clear for years in a well-stoppered bottle. Objects hardened in alcohol are most suited for this method of embedding. Prior to embedding, place them for two or more hours, according to their size, in weak glycerine (glycerine 1 part, water 2 parts), to which some thymol has been added. In order to remove all traces of alcohol, the fluidis changed from hour to hour.

Glycerine and Gelatine.—Alcohol or chromic acid preparations may be placed in a mixture of one volume of a very concentrated solution of isinglass and half a volume of pure glycerine. The whole, when cooled, is to be replaced in chromic acid or alcohol, where they will become sufficiently hard.

Pure Glycerised Gelatine (Dr. E. Kaiser).—Take finest French gelatine, 1 part by weight. Steep for about two hours in 6 parts (by weight) of distilled water, and add 7 parts of pure glycerine. Then to every 100 grms. of the mixture, 1 grm. of a concentrated solution of carbolic acid is added. The whole must be warmed for ten or fifteen minutes, stirring all the while until the flakes produced by the carbolic acid have disappeared. Then filter while still warm through the finest glass, previously washed in distilled water. When cold, the preparation can be used like Canada balsam. This medium is also an excellent embedding substance. For this purpose the objects must be placed in the glycerine-gela-

* Zool. Anseig., viii., 1885.

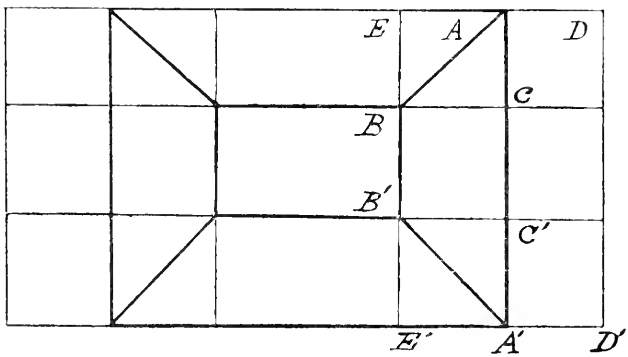
tine after again warming. When sections of objects have to be made so delicate that there is danger of their falling to pieces after cutting, the object must be left in the warmed glycerine-gelatine until it is thoroughly penetrated by the latter. The gelatine may be removed from the tissues by a fine jet of warm water after the section is made and placed on the slide. For embedding hard tissues, it is an excellent medium. Any degree of hardness may be imparted to the tissues by treating with absolute alcohol, the time required for this being from ten to thirty minutes. It is so transparent that the precise position of the object can be seen. In my opinion, it is one of the very best medias for this work.

Celloidin Method of Embedding Sections.—This is a pure pyroxiline, free from all organic constituents, and makes a clear solution free from all sediment when dissolved in equal parts of 95 per cent. alcohol and sulphuric ether. It is manufactured by Shering, of Berlin, and can be obtained from Zimmermann, Mincing Lane, London, E.C., either in a solid or fluid form. The fresh tissue, suitably divided, is hardened, as usual, in either Müller's fluid or alcohol, but is allowed to remain forty-eight hours in *absolute* alcohol, from which it is taken and placed in sulphuric ether for two days. It is then placed in a thin solution of celloidin for the purpose of soaking it through thoroughly; seven to ten days accomplishes this. If very thin sections are wanted, the pieces must be small. If large, the pieces should be of the required size and very thin, so as to allow the celloidin to penetrate easily. Remove to paper boxes, which are filled with this solution and exposed to the air. When the ether and alcohol have evaporated, a crust forms on the surface. Immerse the boxes in a mixture of methylated alcohol and water. Leave them floating in this for about three days, then the celloidin becomes very solid, though elastic, and firmly embeds the specimens. They are now ready for cutting. Specimens prepared thus may be stained in the different fluids when *cut*. Care should be taken when clearing them not to use oil of cloves or absolute alcohol, for both dissolve the celloidin. Use alcohol of 95 per cent. and oil of bergamot, origanum, or sanders. Where origanum oil is

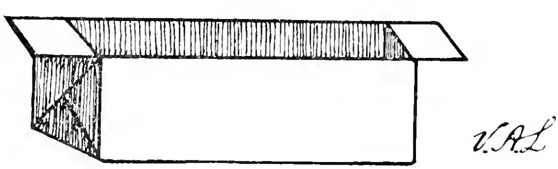
used, let the specimen remain in it from two to four days. Place it on a slide and mount in Canada balsam. This is very good for whole sections of eyes and morbid and normal tissues. When cutting flood the *knife* with alcohol. If further particulars are desired, a similar method is given in *Journal of Anatomy and Physiology* (Oct., 1884).

Embedding in Gum.—A paper box is filled with a very concentrated solution of gum arabic. In this is placed the object from which the water has been drawn by means of alcohol. The whole is then placed in alcohol for two or three days, and is then in a proper condition for cutting. The sections are to be washed with water.

1



2



To Embed the Wax Mass for Cutting.—A piece of stout paper is taken, 6 inches long and 3 inches broad. This is doubled into three longitudinal folds. After this from each end folds of two inches long are marked off. The paper is then opened out, and of the three longitudinal folds the middle one forms the bottom and the lateral ones the sides of the paper box. The ends are made from the middle part of the end folds. The ends of each

flap are marked off into two equal squares, E C, E' C', C' D'. The squares E B, A C, and E' B', A' C' are doubled into two parts across the diameters A B, A' B', and these triangular folds thus made are pinched up and pressed against the end of the box to support it. They are retained in position by the remainder of the end fold, represented by A A' D D', being turned back over them (Figs. 1 and 2). If the student prefers to do so, he can buy a small box made of tin, price 3d., from Stanley, London.

Melt the wax mass, take the specimen upon a needle, and having removed the superfluous absolute alcohol (in which the tissue ought to have been immersed for at least ten or fifteen minutes before the operation is commenced) with blotting paper, half fill the paper box with the melted wax, and dip the specimen in several times until it is thoroughly covered with thin layers of wax. Allow it to cool, and place the tissue on the wax in the box at one end, and fill the box with melted wax; and after it has hardened mark on the outside the position of the tissue. When quite hard, turn out the wax and the tissue by opening the ends of the box, and place for a few minutes in methylated spirit. The tissue is now ready for cutting. It is as well to shave off the corners of the wax, and also to cut off several thin slices from the end near which the specimen is with a sharp knife or scalpel. See that the razor may not be blunted by cutting too much wax.

Cutting Sections with the Microtome.—At the present time there is such an immense number of these instruments, that it makes it rather difficult to advise students. I should recommend them to see the various kinds and learn the points in which they differ, to enable them to see which they prefer. The following are the chief which I shall only just mention, as further particulars can be obtained from looking at the various books on histology or makers' lists:—Ranvier's microtome, a modification of which is made by Beck; Stirling's microtome, which is on the same principle as Ranvier's, but is larger and fixed to a table with a screw; Rutherford's, which has a trough, which may be used to contain a freezing mixture of ice and salt (recently, however, an ether spray has been adapted to it; see *Lancet*, 1885). Rivet's is another form of a microtome, in which the razor is arranged to slide at a

fixed level. *Stirling's* instrument is one of the earliest, a description of which is found in Stirling's "Histology." Dr. Ray's, an account of which will be found in Foster's *Journal of Physiology*, Vol. II., p. 19. It is made by the Cambridge Scientific Instrument Company, as is Caldwell's ribbon section microtome. This latter is an excellent instrument, especially for class working. Its drawback is the expense, but lately a cheaper form has been made. Dr. Urban Pritchard's (*Lancet*, Dec. 11th, 1875) and Williams' freezing microtomes.—The latter is most often in general use. It is known as Swift's "Tub," and has recently been adapted for use with ether as a freezing agent by Dr. Groves.* For those who do not mind the inhalation of atmospheric air charged with ether, the best and simplest ether-freezers for use with Swift's knife is Fearnley's microtome. This is simply the top of the Grove-Williams's instrument, supported by three legs. The ether nozzle is immediately under the frame of the glass plate, and the bottle of ether stands beside the machine on the table. This is also made by Messrs. Swift and Son (Cole). Dr. Bevan Lewis's ether-freezer is specially valuable for rapid freezing.

The latest microtome is Cathcart's ether-freezer, and I can strongly recommend it, from personal experience, for cheapness, simplicity, and efficacy. It cannot be approached by any ether or ice microtome I know. The total cost of microtome with plane-iron is only about 17s. 6d. The maker is Frazer, of Lowthian St., Edinburgh, but it can be obtained from nearly all opticians. With the expenditure of two drams of ether, 60 or 70 sections can be cut in almost as many seconds. In using the microtome a little care is needed, as several have told me the tissue would *not* remain on the plate when frozen. The secret of this is that a little gum solution should be *first placed on the plate* and almost frozen. The tissue to be cut is placed *upon it* and surrounded with gum, and the whole frozen. The tissue is *elevated to the knife* by a revolution of the screw with the left hand, whilst the right drives the plane-iron, which must be held with the edge *far* below the level of the rest of the iron, and the screw-movement and the push of the iron must take place alternately. When a mass of sections

* *Journal of Quek. Micros. Club*, Oct., 1881, Vol. VI., p. 293.

has accumulated on the iron, it must be floated off into a saucer of water, which may be cold or warm. From the bowl of water into which they are put first, they are transferred to a conical glass filled with water, in which they gradually subside. All the gum must be got rid of, which is accomplished by changing the water several times. When all the gum is dissolved, transfer the sections to one or other of the following fluids till they are required. The sections, when cut, should be kept in a glass-stoppered bottle.

Preservative Fluids:—(1) Ordinary methylated spirit. (2) Glycerine, 1 ounce; water, 1 ounce; carbolic acid, 4 minims. (3) Dr. David J. Hamilton, of Edinburgh University, recommends glycerine and distilled water, of each 4 ounces; carbolic acid, 3 drops. Boil and filter. The addition of 2 ounces of alcohol is advisable.

Gum and Syrup Preserving Fluid (Cole).—Specimens may be kept the year round in gum and syrup, having a little carbolic acid in it; if the operator chooses, he can then freeze and cut the tissue so placed at any moment he likes.

To make the Gum and Syrup.—Take of gum mucilage (B.P.) 5 parts. This is made by placing 4 ounces of picked gum acacia in 6 ounces of distilled water, and stirring occasionally until the gum is dissolved. This is to be strained through muslin. Syrup, 3 parts, made by boiling 1 lb. of loaf sugar in 1 pint of distilled water, and boiling; add 5 grs. of carbolic acid to each ounce of the above medium. Tissues may remain in this any length of time. For brain, spinal cord, retina, and all tissues liable to come in pieces, put 4 parts of syrup to 5 of gum. In cutting some materials, such as retina, it is advisable to strain it *en masse* before freezing, otherwise the sections cannot be seen when placed in water. The operator will do well to make the gum mucilage and syrup separately, and keep them so till wanted.

To cut Tissues soaked in Gum and Syrup Medium.—Take a piece of tissue and press it gently between a soft cloth to remove all the gum and syrup from the outside of the tissue. Set the spray going, and paint on the freezing plate a little gum, then put the tissue upon this and surround it with the mucilage, with a camel's hair brush. In this way the tissue is saturated with gum

and syrup, but surrounded when frozen with gum only. This combination prevents the sections curling up, or splintering, from being too hard frozen. Should the freezing have been carried too far, the operator must wait a few seconds. It should cut like cheese with the plane-iron.

Embedding in Egg Mass (Prof. Calberla).—The whites of several eggs are carefully separated from the yolks, and then the fibrous portion known as the chalazeæ is removed, and the rest cut up with scissors. Fifteen parts of the white are now vigorously shaken with one part of a 10 per cent. solution of carbonate of sodium. The yolk is now added, and the shaking repeated, and the subsequent filtering removes the bubbles and fragments of chalazeæ, etc. A small paper tray is filled with the resulting fluid, and immersed in alcohol, which by abstraction of the water coagulates the albumen, forming a solid block for embedding. One of these blocks is taken and washed in water to remove the alcohol, and then dried slightly with blotting paper. Scoop out a small cavity, the surfaces of which are wet with the fluid egg. The object is likewise deprived of alcohol by water, and is then placed in any desired position in the hollow. Now, a drop of alcohol will fasten it firmly by coagulation of the fresh egg. The block is now washed again, and the fluid egg is poured over to cover the object. To confine this egg it is best to place the object and hardened mass in a box, and then pour in fluid egg. The box and contents are then placed in a vessel, and exposed to alcohol steam until the new portion of egg is coagulated. Various plans for thus steaming have been devised. The simplest method is to employ a fruit jar, in the bottom of which a little alcohol is poured. The box is placed in the jar, and the opening closed with a glass funnel. The whole is now heated in a water bath for from thirty to forty minutes, care being taken the alcohol does not boil. The mass is then removed and placed in alcohol, which should be changed once or twice in the first twenty-four hours. It may then be cut at any time, or the cutting may be suspended, and the object kept indefinitely by immersion in alcohol. The object to be cut should be stained before embedding, but the sections need not be freed from the mass before mounting, as the coagulated egg

clears perfectly in oil of cloves. The mass holds together all parts of the section, and is therefore of much use for delicate structures.

Freezing in Gelatine.*—Instead of freezing in gum, as is usual, we use glycerine jelly. This is prepared and clarified in the ordinary way. It should set into a stiff mass when cold; how stiff will be best learned by experience. The tissue to be cut is transferred from water to the melted jelly, and should remain in it till well permeated. It is then placed on the piston of Rutherford's (or any other maker) microtome; the "well" should not be filled; but for adherence it is sufficient to roughen the surface of the portion with a file. Use no more jelly than is necessary to surround the specimen; if too much has been added, it may be removed by carefully paring when well frozen. Slices may be cut in the ordinary way, and should be quickly transferred to the glass slide on which it is to be mounted. On touching the glass, the slice of jelly almost immediately thaws, and adheres as a consistent film to the surface. When enough slices have been placed on the slide, cover each with a drop of glycerine (the sooner this is added the better); a cover-glass is then superposed, zinc white, or some similar cement, is run round it, and the preparation is complete. In time the glycerine will permeate the gelatine, and convert it into glycerine jelly; if this does not take place soon enough, it may be hastened in an oven kept at a temperature of about 20° to 30° C. In this way a series of entire slices of great thinness may be obtained from the most disconnected structures; even when they contain hard, siliceous spiculæ, as in the case of sponges, diatoms, as *Pleurosigma*, etc., they may be cut without difficulty.

Cutting Sections in Ribbons.†—The object of the process is to enable the observer to cut a series of extremely thin sections of any soft preparation, such as an embryo, and to mount the sections in a series in the order of succession, retaining all the parts of the specimen in their proper position. The specimen is first properly prepared, and embedded in paraffin. The paraffin

* *Quart. J. Micro. Science.*

† *Am. Month. Journal of Micros.*

is then placed in the section-cutter, which is made on the principle of the Rivet microtome, although much longer than the usual form of the latter instrument, and somewhat modified in the details of construction. Sections are then rapidly cut by moving the knife forward and backward within proper limits, and the successive sections of paraffin, which are square, adhere together by their edges into a ribbon, which may grow to an indefinite length. It is essential that the paraffin be of the proper consistency and at the right temperature. Glass slides are now prepared by spreading a thin layer of shellac dissolved in cresote on one surface, to which the ribbons are now transferred, two or three being placed parallel on each slide, so that the sections may be readily examined in succession. By heating for a short time in a warm oven, the sections become firmly attached to the slide, and may be mounted in balsam with very little trouble. As a result of this method of procedure a series of sections across the body of *Lingula*, in which the arms were shown in section precisely as in life, and in the stomach were remains of diatoms quite undisturbed by the operation and preparation. (For other methods see *Journal of Microscopy and Natural Science*, Vol. II., p. 225.)

Reports of Societies.

The Manchester Microscopical Society.

From the Transactions and Annual Report of the Society for 1886, we learn that the names of 206 members are now on the roll, that the books and slides in the reference library and cabinet are freely used by the members, that the mounting section numbers 88 members, and that at the monthly meetings of this section an average of about half the members are present.

The volume before us, consisting of about 136 pages, contains a portrait of the President, J. L. W. Miles, M.D., D.Sc., F.R.S., F.R.M.S., etc.; his Presidential Address; a paper by A. J. Doherty on the Staining of Animal and Vegetable Tissues, and 26 other papers of varying length on subjects of much interest to the microscopist, together with a list of honorary, corresponding, and ordinary members.

THE CROYDON MICROSCOPICAL AND NATURAL HISTORY CLUB.

We gather from the Proceedings of this Club, which appear to cover the two years 1884 and 1885, that there are 246 members, 6 honorary members, and 2 associates on the roll, and the finances of the Club are in a very satisfactory state. Seventeen valuable papers appear in the Transactions.

CHESTER SOCIETY OF NATURAL SCIENCE.

We have before us the Sixteenth Annual Report and Statement of Accounts for 1886—87 and the List of Members for 1887—88, and learn from it that the Society is now located in the Grosvenor Museum building, and that during the last year 78 new members have been elected, making a total of 585 members. The work of the Society and the means by which it endeavours to keep alive the interest of the members is described under the following heads:—Excursions; General Lectures; Evening Rambles; Sectional Meetings; Conversazione; and Prizes. Six lectures on subjects of great interest were given during the six winter months, and on alternate dates at the same season several papers were read on subjects relating to Geology, Microscopy, Botany, and Zoology.

HACKNEY MICROSCOPICAL AND NATURAL HISTORY SOCIETY.

We learn from the 10th Annual Report that this Society now consists of 74 members. It is pleasing to notice that the attendance at the meetings has reached a higher average than that of recent years, and that the meeting to which ladies and friends were invited was sufficiently successful to warrant an early repetition. A short abstract only of the papers read is given in the report.

THE EAST KENT NATURAL HISTORY SOCIETY.

We have received No. 2 of the new series of the Transactions of this Society, which contains copies and abstracts of 9 papers read before the Society. These were on The Water-Supply of East Kent; *Bos Longifrons;* Our Social Wasps; A Sanitary Law Exemplified in Vegetable Life; On the Dental Apparatus of the Higher Mollusca; Notes on the Intelligence of a Young Raven; Some Physical Conditions of Smut in Wheat; Malformed Fruit of a Sloe Tree; *Trichinodina* as an Endoparasite; and a number of Short Notes.

The South London Entomological and Natural History Society.

This Society consists of 101 members, 52 of which were added last year. The financial position of the Society is also highly satisfactory. The report before us contains the Presidential Address by Robert Adkin, Esq., F.E.S., and an abstract of proceedings at the general meetings, from which we gather that objects exhibited were well described by their exhibitors and fully discussed, but that no papers were read.

Reviews.

A Guide to Elementary Chemistry for Beginners. By Le Ray C. Cooley, Ph.D. Crown 8vo, pp. xv.—300. (New York: Ivison, Blakeman, Taylor, and Co. 1886.)

In the work before us the author tells us he has made "a judicious selection of the most fundamental facts and principles of chemistry, and to present these in such a way that the student must constantly use his senses to discover facts, his reason in drawing correct inferences from the data he collects, and good English in expressing accurately what he sees and thinks." In the course of experiments, the mechanical operations are described in minute detail. The book treats in a lucid manner on Chemical Changes; the Chemistry of Combustion, of Water, and of the Atmosphere; Compounds of Nitrogen, Hydrogen, and Oxygen: The Composition of Plants: Elements, Molecules, and Atoms; Acids, etc.; Phosphorus; Silicon and the Carbon Group; The Metals, etc. The book is plainly written and well illustrated.

Notes on Histological Methods, including a Brief Consideration of the Methods of Pathological and Vegetable Histology and the Application of the Microscope to Jurisprudence. 8vo, pp. 56.

Notes on Microscopical Methods. 8vo, pp. 32. Both by Simon H. Gage, Assistant Professor of Physiology and Lecturer on Microscopical Technology. (Ithaca, New York, U.S.A.: Andrus and Church. 1885—6, 1886—7.)

These notes were written for the use of the students engaged in the Laboratory of the Anatomical Department of the Cornell University, and in their pages will be found condensed a large amount of most valuable information.

Elements of Botany, including Organography, Vegetable Histology, Vegetable Physiology, Vegetable Taxonomy, and a Glossary of Botanical Terms, illustrated by nearly 500 engravings from drawings by the Author. By Edson S. Bastin, A.M., F.R.M.S. Royal 8vo, pp. xv.—282. (Chicago, U.S.A.: G. P. Engelhard and Co. 1887.)

This will prove a valuable book in the hands of the student. The author has endeavoured to make it teach as much as possible by illustrations, the

whole of which have been drawn by his own hand, and in order that the learner should not find it too technical, the common names of plants have been used as far as practicable, and the most familiar plants have been selected to illustrate structure. A very copious glossary has also been added.

COMPARATIVE MORPHOLOGY AND BIOLOGY of the Fungi, Mycetozoa, and Bacteria. By A. de Bary, Professor in the University of Strasburg. The Authorised English Translation by Henry E. F. Garnsey, M.A. Revised by Isaac Bayley Balfour, M.A., M.D., F.R.S., etc. With 198 illustrations. Royal 8vo, pp. xviii.—425. (Oxford: Clarendon Press. 1887.) Half morocco, price 22s. 6d.

In this fine work the author tells us that he has endeavoured to make his remarks intelligible even to those who are only beginning the study of the Fungi, but has assumed that his readers are masters of such a general knowledge of botanical science as is to be obtained by a course of study in a university or by the use of good text-books. The first portion of the volume treats of the General Morphology, the Course of Development, and The Mode of Life of Fungi; the second part, The Morphology and Course of Development and Mode of Life of the Mycetozoa; the third, Morphology and Mode of Life of the Bacteria or Schizomycetes. Eleven pages at the end of the book are occupied by an Explanation of Terms. There is also an exhaustive index. The illustrations throughout are exceedingly clear and good.

AN INTRODUCTION TO THE STUDY OF LICHENS. By Henry Willey, with a supplement and ten plates. 8vo, pp. 72. (The Author, New Bedford, U.S.A. 1887.) Paper covers, price $1.00.

We have much information here in a comparatively small compass on Collecting and Mounting Lichens; The Lichen, its Structure and Organs; The Distribution of North American Lichens; The History of Lichens; Helps to the Study of Lichen; and the Arrangement of North-American Lichens. The plates show the Thallus, Gonidia, Apothecia, Spermogones, Pycnides, and the Spores; in plates 5—10, the Spores of the Genera are compared.

ZOOLOGICAL PHOTOGRAPHS, being Short and Interesting Chapters on Natural History. By Joseph Hassell, A.K.C.Lond. Crown 8vo, pp. 166. (London: Sunday School Union.)

The subjects in this book are treated in a thoroughly interesting manner, and at the same time the scientific has not been sacrificed to the popular. Modern classification has been kept to throughout, and one or more of the leading creatures in each sub-kingdom have been taken as a type of the whole. For the assistance of teachers and the instruction of older scholars, a general view of the sub-kingdom is given at the end of each group. The book consists of 15 chapters, commencing with the History of a Sponge as told by itself up to the Story of the Cuttle Fish. The illustrations are numerous and good.

HANDBOOK OF THE FERN-ALLIES: A Synopsis of the Genera and Species of the Natural Orders, Equisetaceæ, Lycopodiaceæ, Selaginellaceæ, and Rhizocarpeæ. By J. G. Baker, F.R.S., F.L.S., etc. 8vo, pp. 159. (London: Geo. Bell and Sons. 1887.) Price 5s.

This useful work is planned upon the same lines as Hooker and Baker's "Synopsis Filicum," and the two taken in connection cover the whole series of the Vascular Cryptogamia. The synopsis proper occupies the first 150 pages, and is followed by a valuable key to the Orders and Genera, beyond

which is an alphabetical index to all the species arranged under their various genera.

THE PROPAGATION OF PLANTS. By Andrew S. Fuller. Illustrated with numerous engravings. Crown 8vo, pp. 349. (New York: O. Judd and Co. 1887.)

This book gives (to copy the full title) the principles which govern the Development and Growth of Plants, their Botanical Affinities, and Peculiar Properties: also, Descriptions of Processes by which Varieties and Species are Crossed or Hybridised, and the many different methods by which Cultivated Plants may be Propagated and Multiplied. It treats very fully of the Life-history of Plants; Movement and Reorganisation of Cells; Origin and Kind of Buds; Roots and their Functions; Stems and their Appendages, etc. It is well illustrated and printed on good paper.

OUR LANES AND MEADOW-PATHS; or, Rambles in Rural Middlesex, with illustrations and a map. By H. J. Foley. Crown 8vo, pp. viii.—113. (London: Hutchins and Crowley.)

A number of country walks have been taken and pleasantly described in the 23 chapters into which this little book is divided, and in these the author shows how much of picturesque beauty and interest lies within the reach of those living in the north of London whose means and time are limited.

SUNLIGHT. By the author of "The Interior of the Earth." Second edition, with alterations and additions. Post 8vo, pp. xii.—180. (London: Trubner and Co. 1887.) Price 5s.

The author of this little work suggests that light was the first cause of the creation of the earth, acting on a nebulous mass that held in it gases or material sensitive to, absorptive, and retentive of that light.

OUR BIRD ALLIES. By Theodore Wood. Foolscap 8vo, pp. x.—214. (London: Society for Promoting Christian Knowledge. 1887.) Price 2s. 6d.

In this little book, which may be considered as a continuation of the series, *Our Insect Allies* and *Our Insect Enemies*, the author shows that no British bird is utterly and wholly destructive, but that the misdeeds of even the most mischievous are atoned for in some degree by services rendered in other ways; thus, two chapters are devoted to the sparrow, one in which its vices are unfolded, the other describing its virtues. The arguments for the defence are certainly powerful, but we leave the readers to act as jury.

BIRD-LIFE IN ENGLAND. By Edward Lester Arnold. Crown 8vo, pp. x.—325. (London: Chatto and Windus. 1887.) Price 6s.

A series of interesting papers on many of our more common birds, written by an experienced sportsman. He tells of Hawks and Owls, Finches, Crows, Marsh Birds, Grouse, Partridges and Pheasants, Pigeons, Ducks, Sea-Fowl, Grouse-Moors, Deer-Forests, and of many other matters interesting to the sportsman and the agriculturist.

PATERSON'S GUIDE-BOOK TO ENGLAND AND WALES, with Maps and Plans. 12mo, pp. 420. Price 4s.

PATERSON'S GUIDE-BOOK TO THE UNITED KINGDOM, with

Maps and Plans. 12mo, pp. 580. (Edinburgh and London: William Paterson. 1887.) Price 6s.

Two most useful books for the tourist, giving him such information as will enable him intelligently to visit all places of importance in the United Kingdom. Most of the routes are arranged on the main lines of railway, but many outlying places of interest are not omitted. Both books contain a number of small but very well executed maps, plans of towns and cathedrals. The plans of towns we consider exceedingly good.

OXFORD, CAMBRIDGE, AND LONDON ARITHMETIC QUESTIONS, with Answers from Stewart's Home and Class Book of Arithmetical Questions. By John Stewart. Post 8vo, pp. 440. Price 1s. 6d.

This consists of Tables; Oxford and Cambridge Worked-Out Examples; London University and College of Preceptors' Papers; and Oxford and Cambridge Local Examination Papers from 1864 to 1884, with Answers. We recommend a youth to work out some of these problems before going up for his exam.

THE RULING PRINCIPLE OF METHOD applied to Education. By Antonio Rosmini Serbati, translated by Mrs. William Grey. Crown 8vo, pp. xxv.—363. (Boston, U.S.A.: D. C. Heath and Co. 1887.) Price $1.50.

This learned Italian writer, who died before the completion of his work, divided the life of a child into several stages or periods—the first from birth and extending about six weeks; the second ending with the child's first articulate word or about the end of the first year. The work of Rosmini reaches to the fifth period, which seems to extend to the time when, as is commonly said, the child acquires the free use of reason. We have in this book first a sketch of the life of Rosmini; the rest of the work is divided into two books:—I.—On the Ruling Principle of Method; II.—Its Application to Little Children.

THE AMERICAN SUNDAY-SCHOOL. By John H. Vincent. Post 8vo, pp. 344. (London: Sunday School Union. 1887.) Price 3s. 6d.

This book is based upon what is sometimes called "the American idea of Sunday-school work," and is to some extent a report of the American Sunday-school system in actual operation. The author has himself served as teacher, superintendent, pastor, and normal-class conductor, and for 35 years has been a close and careful observer of the Sunday-schools on both sides of the ocean. We ean recommend the book to teachers of both sexes.

THE UNWRITTEN RECORD: A Story of the World We Live On. By James Crowther, with an Introductory Note by J. R. Macduff, D.D. Crown 8vo, pp. viii.—176. (London: Sunday-Sehool Union.) Price 2s. 6d.

The very popular author of this little *brochure* appears to have a happy way of harmonising the utterances of the two great volumes of Nature and Revelation, and making the one the exponent and interpreter of the other. He most certainly has done so in the present case. Amongst the many interesting chapters are the following:—The Pre-Adamite World; The First Day; The Earth's Surface; Corals and Coral Reefs; A Ramble in a Chalk Bed, and many others, which our young friends will do well to read.

ANCIENT NINEVEH: A Story for the Young, with numerous illustrations. Fourth edition, revised and enlarged. Crown 8vo, pp. 115. (London: Sunday Sehool Union.) Price 1s. 6d.

Tells us the Bible history of Nineveh, her Classic History, and her History

told by Herself, followed by a History of the Discovery of Nineveh. It is nicely illustrated.

THE HISTORY OF THE PACIFIC STATES OF NORTH AMERICA. By Hubert Home Bancroft. Vol. I., Central America Vol. I., 1501—1530. 8vo, pp. lxxii.—704. (San Francisco, U.S.A.: The History Co. 1882.)

In 1875 the author published, under the title of *The Native Races of the Pacific States*, what he believes to be an exhaustive research into the character and customs of the aboriginal inhabitants of the western portion of North America at the time they were first seen by their subduers. The volume before us is the first volume of a history of the same territory from the coming of Europeans. Mr. Bancroft has undertaken a colossal work and is carrying it out in a most masterly manner. We are informed the entire series will cover 39 volumes.

DUE NORTH; or, Glimpses of Scandinavia and Russia. By Maturin M. Ballou. Crown 8vo, pp. xii.—372. (Boston, U.S.A.: Teeknor and Co. 1887.)

The author of this book has previously written two very popular works, one entitled "Due West, or Round the World in Ten Months," the other, "Due South, or Cuba Past and Present." The volume before us describes the far north, from which the author has just returned, including Norway, Sweden, Russia, and Russian-Poland. His travels are very pleasantly described, and the book will be read with much interest.

BY NORTHERN SEAS. By Mary Bell. Post 8vo, pp. 357. (London: Church Extension Association.)

An interesting story in 23 chapters, of a specially religious turn.

A MISUNDERSTOOD MIRACLE: An Essay in favour of a New Interpretation of "The Sun Standing Still" in Joshua x. 12—14. By Rev. A. Smythe Palmer, B.A. Crown 8vo, pp. vii.—119. (London: Swan Sonnenschein and Co. 1887.) Price 3s. 6d.

The author suggests that if the words given in the margin were substituted for the words "stand still," they would throw quite a different light on this passage. At the same time, he quotes numerous instances where the word "stood" is used in the Old Testament to express "stayed, desisted, or ceased to discharge its function." The question is exceedingly well argued and is worth careful perusal.

"WE DONKEYS" ON THE COAST OF DEVON. By M. S. Gibbons, F.S.Sc. (Lond.), author of "We Donkeys in Devon," "We Donkeys on Dartmoor," etc. 12mo, pp. 112. (London: Simpkin, Marshall, and Co. Exeter: T. Upward. 1887.) Price 1s.

Gives principally a description of the various churches in the neighbourhood of the Devonshire coast. As the book contains neither preface or introduction, and as we have not seen the earlier volumes of the series, we do not quite understand the title, "We Donkeys," but conclude from pictures on the advertisement pages that the carriage of the fair authoress is drawn by a pair of donkeys.

ELECTRICITY AND HEALTH. Crown 8vo, pp. 100. (Blackpool: G. Cohen.) Price 3s. 6d.

This little book is described in the title as being an exposition of the most scientific and rational methods of applying Medical Electricity to the Cure of

Acute and Chronic Disease. There are several illustrations. Herr Cohen is well known as a popular lecturer on Phrenology, etc.

NOTABLE WORKERS IN HUMBLE LIFE. Crown 8vo, pp. 219. By Rev. E. N. Hoare, M.A. (London: T. Nelson and Sons. 1887.) Price 2s.

An interesting account, written for young people, of those remarkable men, John Pounds, John Duncan, Robert Dick, Thomas Edward, John Ashworth, Thomas Cooper, Robert Flockhart, and George Smith. A portrait of Robert Dick forms a frontispiece to this little volume, and a vignette of John Ashworth adorns the title-page. The biographies are pleasingly told.

THE SCIENCE OF COMMON THINGS. By John A. Bower, F.C.S. Fcap 8vo, pp. v.—165. (London: Sunday School Union.)

A series of articles on things met with in every-day life, as, *e.g.*, Our Weather-Glass, The Kitchen-Pump, How a Thermometer is made, A Lump of Ice, A Magnifying Glass, etc. The information is given plainly and simply, and is likely to prove of much profit to the reader.

LECTURES delivered before the Sunday Lecture Society, Newcastle-on-Tyne. Crown 8vo, pp. 173. (London: Walter Scott. 1887.)

A series of seven most interesting lectures, which we have read with much pleasure. They embrace the following subjects:—The Natural History of Instinct, by G. J. Romanes, F.R.S.; Animal Life on the Ocean Surface, by Professor H. N. Moseley, M.A., F.R.S.: The Eye and its Work, by Litton Forbes, M.D., F.R.C.S.E.; The Movement of Plants, by Ernest A. Parkyn, M.A.; The Relations between Natural Science and Literature, by Professor H. Nettleship, M.A.; Facts and Fictions in Zoology, by Andrew Wilson, F.R.S.E.; The Animals that make Limestone, by Dr. P. Herbert Carpenter, F.R.S. The names of the authors will sufficiently guarantee the value of the lectures.

THE PRIOR OF GYSEBURNE (Gisborough): A Chronicle of Olden Times, in the Days of Richard the Second, Henry the Fourth and Fifth. By the Rev. F. H. Morgan, M.A. Crown 8vo, pp. 415. (Saltburn-by-the-Sea: W. Rapp and Sons. London: Simpkin, Marshall, and Co. 1887.) Price 5s.

This interesting account of Gisborough Priory in the days of Richard II. and Henry IV. and V. is compiled in a great measure from a curious old MS. in the author's possession. A very pretty photograph of the ruins of the Priory and Grounds of Gisborough forms a frontispiece to the volume.

A BOY'S ADVENTURES IN THE WILDS OF AUSTRALIA; or, Herbert's Note-Book. By William Howitt. With illustrations by William Harvey. Post 8vo, pp. 376. (London: George Routledge and Sons.) Price 3s. 6d.

A book which every boy will delight in reading. It was written amid the scenes and characters which it describes. The adventures are well told and the illustrations are good.

GLEANINGS FROM THE BOOK OF RUTH; or, the Book of Ruth opened out by comparison with other parts of Scripture. By Robert Brown. Crown 8vo, pp. vi.—260. (London: S. W. Partridge and Co.)

The subject-matter of this book forms a series of lectures or Bible-readings which were delivered by the author at different times. The author remarks that the *names*, both of the persons and of the places mentioned in the Book of Ruth, are wonderfully suggestive, and that they furnish a clue to the metaphorical understanding of the book itself.

AMERICAN MEDICINAL PLANTS, an Illustrated and Descriptive Guide to the American Plants used as Homœopathic Remedies: their History, Preparation, Chemistry, and Physiological Effects. By Charles F. Millspaugh, M.D. (New York and Philadelphia: Boericke and Tafel.)

We have just received the sixth and concluding part of this grand work, which now consists of ONE HUNDRED AND EIGHTY coloured plates, each plate being 12 inches by 8¾ inches, and the complete text of all the proven plants indigenous and naturalised in the United States arranged *generically*, according to the numerical order of the plates. Every plant mentioned in this work is drawn and painted by the author, "by his own hand, from the specimens as they stood in the soil," he making mathematically accurate drawings and avoiding the misrepresentations of wilted individuals, or too highly coloured fancy pictures.

In describing the general plan of the work, we may observe that—first, the natural order under which the plant falls is given in prominent types, and should the order be a large one the tribe then follows to give a better idea of its place; then the genus is mentioned in **black-face type,** together with the name of the scientist who formed it; to the genus is generally appended a footnote, showing the derivation of the name; and lastly is given the old, or sexual, arrangement according to Linnæus.

A COURSE OF PRACTICAL INSTRUCTION IN BOTANY. By F. O. Bower, D.Sc., F.L.S., etc., and Sydney H. Vines, D.Sc., F.R.S., F.L.S., etc. Part II., Bryophyta—Thallophyta. Crown 8vo, pp. viii.—144. (London: Macmillan and Co. 1887.) Price 4s. 6d.

On page 126 of the fifth volume of this journal we had the pleasure of writing a short notice of the first part of this useful work; we are glad now to have the opportunity of directing the attention of our readers to the second and concluding part of the work. In this, as in the first parts, well-known plants are chosen to serve as typical representatives of the groups to which they belong. Thus, *Polytrichum commune* and *Sphagnum* are chosen to represent the Mosses and *Marchantia polymorpha* the *Hepaticæ*: of the plants, the general external characters are first described, and this is followed by its microscopical investigation.

MUSHROOMS FOR THE MILLION, illustrated with Supplement: A Practical Treatise on the Cultivation of the most profitable Outdoor Crop known. By J. Wright, F.R.H.S. Crown 8vo, pp. 128. (London: *Journal of Horticulture* Office. 1887.) Price 1s..

A fifth and enlarged edition of this useful work has just been published. It contains a large amount of valuable information.

THE CHRISTIAN WORLD MAGAZINE, Midsummer Vol., 1887. 8vo, pp. 552. (London: James Clarke and Co.) Price 4s.

This is the first volume of a new series, and we congratulate the publishers on the improvement in size. It is, however, the 23rd volume from its commencement, and comprises a number of papers and complete stories by well-known writers, together with a serial story, which does not appear to be completed in the present volume.

MY MICROSCOPE, and Some Objects from My Cabinet: A Simple Introduction to the study of the "Infinitely Little." By a Quekett Club Man. Post 8vo, pp. 78. (London: Roper and Drowley. 1887.)

In this little book the Microscope and a few attractive objects are described in very plain language. It will be a good book to give to those who are not acquainted with the use of the microscope, as it will most probably create a desire for the possession of such an instrument.

MICROSCOPY FOR BEGINNERS; or, Common Objects from our Ponds and Ditches. By Alfred C. Stokes, M.D. Cr. 8vo, pp. xiii.—308. (New York: Harper Bros. 1887.)

This little book, as its title states, is intended for the beginner. It commences, of course, with a description of the microscope, and then gives a chapter descriptive of Some Aquatic Plants useful to the Microscopist, followed by others on Desmids, Diatoms, Rhizopods, Infusoria, Aquatic Worms, etc. etc. There are 178 illustrations.

THE ICELANDIC DISCOVERERS OF AMERICA; or, Honour to whom Honour is Due. By Marie A. Brown. Post 8vo, pp. 213. (London: The Author, at the American Exhibition. 1887.) Price 7s. 6d.

Miss Brown, the authoress of this interesting book, uses very strong arguments to prove that America was discovered by the Norsemen in the tenth century, or five hundred years before the time of Columbus. The book is nicely illustrated, and will doubtless be read with much interest.

HILLS AND VALLEYS. (Birmingham: C. Caswell.) Price 2s.—A collection of short poems, illustrated by very pretty coloured pictures of Swiss mountain scenery.

THE STATISTICAL ATLAS OF COMMERCIAL GEOGRAPHY. By E. J. Hastings. 4to, pp. 167. (Edinburgh and London: W. and A. K. Johnston. 1887.) Price 2s. 6d.

In this work we have a series of diagrams, based on carefully collected facts, illustrating the principal points in connection with the commerce of the United Kingdom and its Dependencies and of other leading countries. The diagrams consist of a series of squares, each square representing a certain value or quantity, the amount being stated on each sheet; the statistics on which these diagrams are based being all taken from parliamentary and official returns. The diagrams, which are neatly printed in toned ink, impress the information they are intended to convey at once on the eye, and thence to the mind, and will be found much more effectual for giving statistical information than a long array of figures.

JOHN HEYWOOD'S COUNTY ATLAS OF ENGLAND AND WALES. 4to. (Manchester and London: John Heywood.) Price 1s.

A series of forty-five very nicely engraved maps, showing all the Railways and Coach-roads, Cities, Towns, Parks, and Gentlemen's Estates, and the distances of all the principal towns from London by road.

THE SCHOLAR'S GEOGRAPHY, especially prepared for Elementary Schools. By J. S. Horn. New edition, revised and corrected to

July, 1887. Foolscap 8vo, pp. 177. (Manchester and London: John Heywood. 1887.) Price 1s.

This is a very cheap little book, and furnishes a large amount of useful information in a small space. It is well and clearly printed, all the important words being in bold, black type.

THE PUPIL TEACHER'S SECOND YEAR BOOK, Atlas, and Geography. Post 8vo. (Edinburgh and London: W. and A. K. Johnston.) Price 2s. 6d.

We are pleased to notice a new edition of this important series of Geographical Year Books. The one before us contains eight maps, viz.—Europe, South-West Europe, Central Europe, Southern Europe, India and Ceylon, British Empire, Parallels of Latitude, and Longitudes or Meridians. The letterpress part of the work is very good, the various countries being described under the following heads, viz.—Position and Form, Extent and Area, Political Divisions, Population, etc. etc.

HOW TO TEACH ARITHMETIC. Illustrated in a Series of Notes of Lessons. By T. J. Livesey. Sm. 4to, pp. viii.—95. (London: Moffatt and Paige.) Price 2s. 6d.

The author, who is Master of Method and Lecturer on School Management, and author of Moffatt's Scholarship Answers, gives some simple and useful hints on How to Teach Arithmetic, each rule being taken in its proper order and thoroughly explained. Scholars, who find arithmetic difficult, would do well to study this book, and so become their own teachers.

MOFFATT'S PENNY ATLAS.

MOFFATT'S SELECTED INSPECTOR'S ARITHMETIC QUESTIONS. (London: Moffatt and Paige.) Standards III., IV., V., and VI., Price 1d each; Standard VII., 2d.

The little atlas consists of fifty-five maps and plans, but are, of course, too small to be of much practical use. In the political map of England all the counties, with their chief towns, are distinctly marked.

The Selected Inspector's Arithmetic Questions are carefully expressed and well arranged.

PRACTICAL LESSONS IN NURSING. Outlines for the Management of Diet. By Edward Tunis Bruen. Cr. 8vo, pp. 138. (Philadelphia: J. B. Lippincott and Co. 1887.) Price $1.

This forms one of a series of Practical Lessons on Nursing. The substance of the present volume was delivered in the form of lectures to the nurses of the Training Schools of several hospitals in Philadelphia. The scientific aspect of the subject has been subordinated to the presentation of some practical suggestions to guide in the selection of suitable foods for different conditions of health and at different periods of life.

THE NEW CRISIS. By Geo. W. Bell. Cr. 8vo, pp. 351. (Des Moines, Iowa, U.S.A.: Moses Hull and Co. 1887.)

Mr. Bell reviews the political situation of America in a masterly manner. His book consists of eighteen chapters, not of dry statistics, but of arguments, in which he unquestionably believes that he is in the right.

Natural History of the Coast of Lancashire. By Thomas Alcock, M.D. (Manchester and London: John Heywood. 1887.) Price 6d.

A short but interesting description of that portion of the coast of Lancashire which extends from the mouth of the Wye to the estuary of the Mersey.

Traced Through a Dream. By Cecil Courtenay.

The Park Lane Mystery. By Joseph Hatton.

The Irish Sphinx. By Thomas J. Passmore.

Three volumes of Arrowsmith's well-known Bristol Library. Price 1s. each.

List of Plates.

Index to Vol. VI.

REVIEWS.

C. SEERS, PRINTER, 1 ARGYLE ST., BATH.

I.] JANUARY, 1887. [Part

THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE:

THE JOURNAL OF The Postal Microscopical Society.

PUBLISHED QUARTERLY.

"Knowledge is not given us to keep, but to impart: its worth is lost in concealment."

EDITED BY

ALFRED ALLEN,

HONORARY SECRETARY OF THE POSTAL MICROSCOPICAL SOCIETY;

ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

LONDON:
BAILLIÈRE, TINDALL, & COX, KING WILLIAM ST., STRAND, W.C.

BATH:
1, CAMBRIDGE PLACE.

C. SEERS, PRINTER, 1, ARGYLE STREET, BATH.

Price One Shilling and Sixpence.

ENTERED AT STATIONERS' HALL.

Vol. VI.] APRIL, 1887. [Part 22.

THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE:

THE JOURNAL OF The Postal Microscopical Society.

PUBLISHED QUARTERLY.

"Knowledge is not given us to keep, but to impart; its worth is lost in concealment."

EDITED BY
ALFRED ALLEN,
HONORARY SECRETARY OF THE POSTAL MICROSCOPICAL SOCIETY;
ASSISTED BY
SEVERAL MEMBERS OF THE COMMITTEE.

LONDON:
BAILLIÈRE, TINDALL, & COX, KING WILLIAM ST., STRAND, W.C.

BATH:
1, CAMBRIDGE PLACE.

C. SEERS, PRINTER, 1, ARGYLE STREET, BATH.

Price One Shilling and Sixpence.

ENTERED AT STATIONERS' HALL.

CONTENTS.

THE POSTAL
MICROSCOPICAL SOCIETY

THE SOCIETY was formed in 1873 to aid in the study, discussion, and circulation of Microscopic objects, and to advance the pursuit of Natural Science among its members.

It is divided into thirteen Circuits of about twelve members each, arranged geographically. A box of Slides accompanied by MS. book for the insertion of Notes and Memoranda, is sent by the Hon. Secretary, at fortnightly intervals, to the first member on one of the Circuits; who, after keeping it for three days, must send it on by post to the next on the list, and he to the following one. When it has gone round the Circuit, the last member returns it to the Hon. Secretary, who will then forward it to the first member of the next Circuit, and so on, until the slides have been seen by the whole of the Society. Each member is expected to contribute six Slides annually, which are returned to him after they have been round the Circuits. Ladies, as well as gentlemen, may be elected members of the Society.

A special section has been formed for Members of the Medical Profession.

Entrance fee, Five Shillings; Annual Subscription, Ten Shillings; dating from 1st October in each year.

A copy of the Journal is posted free to each member on day of publication.

All communications on matters connected with the Society, or with this Journal, should be addressed to Mr. ALFRED ALLEN, as above.

Vol. VI.] JULY, 1887. [Part 23.

THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE:

THE JOURNAL OF

The Postal Microscopical Society.

PUBLISHED QUARTERLY.

"Knowledge is not given us to keep, but to impart: its worth is lost in concealment."

EDITED BY

ALFRED ALLEN,

HONORARY SECRETARY OF THE POSTAL MICROSCOPICAL SOCIETY;

ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

LONDON:

BAILLIÈRE, TINDALL, & COX, KING WILLIAM ST., STRAND, W.C.

BATH:

1, CAMBRIDGE PLACE.

C. SEERS, PRINTER, 1, ARGYLE STREET, BATH.

Price One Shilling and Sixpence.

ENTERED AT STATIONERS' HALL.

CONTENTS.

THE POSTAL
MICROSCOPICAL SOCIETY

PRESIDENT—
J. W. MEASURES, M.R.C.S.E., Cobden House, Patmos, Todmorden.

PATRONS—
HIS GRACE THE DUKE OF ARGYLE.
Sir JOHN LUBBOCK, Bart., F.R.S., F.R.M.S., F.L.S., F.G.S.
The Rev. W. H. DALLINGER, LL.D., F.R.S., F.R.M.S., F.L.S.
Dr. LIONEL S. BEALE, F.R.S., F.R.M.S., etc.
Dr. JABEZ HOGG, F.R.M.S., etc.
J. W. GROVES, Esq., F.R.M.S., etc.

HON. SECRETARY—
ALFRED ALLEN, 1 Cambridge Place, Bath.

THE SOCIETY was formed in 1873 to aid in the study, discussion, and circulation of Microscopic objects, and to advance the pursuit of Natural Science among its members.

It is divided into thirteen Circuits of about twelve members each, arranged geographically. A box of Slides accompanied by MS. book for the insertion of Notes and Memoranda, is sent by the Hon. Secretary, at fortnightly intervals, to the first member on one of the Circuits; who, after keeping it for three days, must send it on by post to the next on the list, and he to the following one. When it has gone round the Circuit, the last member returns it to the Hon. Secretary, who will then forward it to the first member of the next Circuit, and so on, until the slides have been seen by the whole of the Society. Each member is expected to contribute six Slides annually, which are returned to him after they have been round the Circuits. Ladies, as well as gentlemen, may be elected members of the Society.

A special section has been formed for Members of the Medical Profession.

Entrance fee, Five Shillings; Annual Subscription, Ten Shillings; dating from 1st October in each year.

A copy of the Journal is posted free to each member on day of publication.

All communications on matters connected with the Society, or with this Journal, should be addressed to Mr. ALFRED ALLEN, as above.

Vol. VI.] OCTOBER, 1887. [Part 24.

THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE:

THE JOURNAL OF The Postal Microscopical Society.

PUBLISHED QUARTERLY.

"Knowledge is not given us to keep, but to impart: its worth is lost in concealment."

EDITED BY

ALFRED ALLEN,

HONORARY SECRETARY OF THE POSTAL MICROSCOPICAL SOCIETY;

ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

LONDON:

BAILLIÈRE, TINDALL, & COX, KING WILLIAM ST., STRAND, W.C.

BATH:

1, CAMBRIDGE PLACE.

C. SEERS, PRINTER, 1, ARGYLE STREET, BATH.

Price One Shilling and Sixpence.

ENTERED AT STATIONERS' HALL.

CONTENTS.

THE POSTAL
MICROSCOPICAL SOCIETY

THE SOCIETY was formed in 1873 to aid in the study, discussion, and circulation of Microscopic objects, and to advance the pursuit of Natural Science among its members.

It is divided into thirteen Circuits of about twelve members each, arranged geographically. A box of Slides accompanied by MS. book for the insertion of Notes and Memoranda, is sent by the Hon. Secretary, at fortnightly intervals, to the first member on one of the Circuits; who, after keeping it for three days, must send it on by post to the next on the list, and he to the following one. When it has gone round the Circuit, the last member returns it to the Hon. Secretary, who will then forward it to the first member of the next Circuit, and so on, until the slides have been seen by the whole of the Society. Each member is expected to contribute six Slides annually, which are returned to him after they have been round the Circuits. Ladies, as well as gentlemen, may be elected members of the Society.

Entrance Fee, Five Shillings; Annual Subscription, Ten Shillings; dating from 1st October in each year.

A copy of the Journal is posted free to each member on day of publication.

All communications on matters connected with the Society, or with this Journal, should be addressed to Mr. ALFRED ALLEN, as above.